

## Stream Flow and USGS Data for the Santa Cruz River

1. ***Santa Cruz River is an effluent dominated stream.*** The published water resources data from the US Geological Survey (USGS) identifies the flow in Study Area A and B as arising from discharges from wastewater treatment facilities to distinguish the flow from other surface and ground water sources. Flow in Study Area A (upper Santa Cruz) is effluent discharged from the Nogales International Boundaries Wastewater Treatment Plant located in Rio Rico, Arizona. Flow in Study Area B (lower Santa Cruz) results from discharges from the Roger Road and Ina Road wastewater treatment plants. Without releases from these treatment plants, flow in both of these reaches would be greatly diminished in frequency and volume to the point that the study reaches would likely be dry for most of the year.
  - a. The Corps' *Gila River, Santa Cruz River Watershed, Pima County Arizona* also identifies the flow as effluent dominated.
  - b. The Corps' Tres Rios del Norte Feasibility Study's Without Project conditions assumes that, the effluent flow would be diverted for recharge and direct re-use "*it is expected that under future without-project conditions, growth and development pressures would increase the economic value of the effluent to such a point that the owners of that water may no longer choose to discharge it into the river but would instead utilize it, to some degree, for other economic purposes.*"
  - c. Arizona defines the Santa Cruz River as an effluent dominated stream and has set water quality standards for "partial body contact" as a regulatory standard for the quality of effluent discharge, not for the purpose of navigation or recreational use.
  - d. Effluent flow in desert streams is man made and should not be considered as the "natural and ordinary condition" when evaluating navigability.
2. ***Use of stream flow data mean or monthly daily flow.*** Given the intermittent character of streamflow in the desert southwest, long-term mean data can easily be skewed by infrequent large events. The US Geological Survey (USGS) publishes the maximum and minimum flows, the standard deviation and the coefficient of variation in addition to the mean.
  - a. At the Amado site for the period of record (October 1, 2003-September 30, 2007), the calculated mean daily discharge for July 19 is 175 cfs. The published data for the USGS Water Resources Data Water Years 2004, 2005, 2006, and 2007 for July 19<sup>th</sup> over the 4-year period of record are 650, 46, 3.2, and 0.86 cfs.
    - i. It is highly questionable if perennial flow exists at or downstream of the Amado gage site (approximately midway through Area A). At the Amado gage using the USGS published data over the 4-year period of record, for the period July-October (192 days per year or 768 days for the period of record) the daily mean value exceeded 50 cfs during only 58 out of 768 days (7.6%) and on only 119 days (15%) did the flow exceed 10 cfs.
    - ii. For the period December-January (62 days per year or 248 days for the period of record), the daily mean value never exceeded 50 cfs and the daily mean value exceeded 10 cfs on 55 days (22%).

- b. At Continental, for the period of record (October 1, 1939 – September 30, 2007) at the gage at Continental (Study Area A), the mean of daily mean values are skewed upward by infrequent large flow events. Published data indicate daily mean values of 0.00 cfs for most days throughout the period of record. As illustrated in a published report from the 2004 Water Year, the annual days with no flow in the Santa Cruz River at Continental is 300 days.
  - c. At Cortaro, for the period of record (October 1, 1939 to September 30, 2007) the records are considered poor because the gage has been relocated 5 different times and from sewage plant disposal into the river has been included in water years 1951, 1952, 1970-82 and from 1990 to present. The discharge of effluent into the Santa Cruz River from Roger Road and Ina Road presently has a daily average of 77 cfs. These various factors make use of the mean daily discharge based on the period of record unreliable.
3. ***Determining Stream Gage Height.*** Gage height is a reference height highly and should not be confused with the depth of flow in a stream, this is especially true in Arizona with ephemeral streams and the potential changes in the stream bed from erosion and/or deposition. Gage height can not be used to estimate stream flow depth, for example the gage height of 21 feet for the Tubac stream gage certainly does not mean the depth of flow is 21 feet. Gage height also varies depending on the type and purpose of the stream gage. The National Weather Service information on gage height is intended to be used for flood warning and the gage height is purposely set above daily flow values at 2 to 3 feet above the bed of the channel. Therefore even when there are no flows in the River, a default gage height of 2 feet would be indicated.
4. ***Variability of Stream Flow in the Santa Cruz River.*** Statistical analyses of stream flow in the Santa Cruz River as published by the USGS illustrate the wide variability in monthly and annual flows (USGS Water Resources Investigations Report 98-4225). When looking at daily flows in the arid southwest the use of mean daily flow is meaningless and a more appropriate tool would be reviewing the number a days annually with no flow (USGS Water Resources Data Arizona Water Year 2004). For the Santa Cruz at Tucson, Congress Street, more than 50% of the monthly discharge values are zero for the months of October through June. Monthly flows only become measurable in July, August and September. An investigation by the USGS of stream flow in southeastern Arizona indicated 58% of the annual flow occurs in the summer months for the San Pedro and Santa Cruz Rivers (USGS Professional Paper 1712).

**Attachments for Santa Cruz River from:**

USGS Water Resources Investigations Report 98-4225, Statistical Summaries of Streamflow Data and Characteristics of Drainage Basins for Selected Streamflow-Gaging Stations in Arizona Through Water year 1996.

USGS Water Resources Data Arizona Water Year 2004

USGS Professional Paper 1712, Trends in Streamflow of the San Pedro River, Southeastern Arizona, and Regional Trends in Precipitation and Streamflow in Southeastern Arizona and Southwestern New Mexico.



Prepared in cooperation with the State of Arizona and with other agencies

# **Water Resources Data Arizona Water Year 2004**

Water-Data Report AZ-04-1

U.S. Department of the Interior  
U.S. Geological Survey



## GILA RIVER BASIN

193

## 09480500 SANTA CRUZ RIVER NEAR NOGALES, AZ

**LOCATION.**--Lat 31°20'40", long 110°51'03", in NW¼ sec. 18, T.24 S., R.15 E. (unsurveyed), Santa Cruz County, Hydrologic Unit 15050301, in Spanish land grant of Maria Santisima del Carmen, on left bank 0.8 mi downstream from international boundary and 5.5 mi east of Nogales.

**DRAINAGE AREA.**--533 mi<sup>2</sup>, of which 348 mi<sup>2</sup> is in Mexico.

**PERIOD OF RECORD.**--Mar. to Nov. 1907 and Apr. 1909 to Dec. 1912 (discharge measurements and fragmentary gage-height record), Jan. 1913 to June 1922 (Oct. 1915 to Sept. 1916 monthly discharge only), May 1930 to Dec. 1933, July 1935 to current year. Water-year estimates for 1913, 1915-16, 1920-22, 1930, 1934-35, published in WSP 1733.

**REVISED RECORDS.**--WSP 959: 1935(M). WSP 1213: 1915-16, 1930-32(M), 1934(M), 1936-37(M). WSP 1283: Drainage area.

**GAGE.**--Water-stage recorder. Datum of gage is 3,702.54 ft above sea level (levels by International Boundary and Water Commission). Prior to June 30, 1922, nonrecording gage or water-stage recorder at various sites 5 to 6 mi downstream at different datums.

**REMARKS.**--Records fair, except for estimated daily discharges, which are poor. Diversions above station of about 4,300 acre-ft/yr for irrigation of about 2,150 acres in Mexico in 1977. Diversion 19 mi upstream for municipal supply of city of Nogales, Sonora, began in 1949; diversion in 1968 totaled 3,500 acre-ft/yr.

**EXTREMES FOR PERIOD 1930-2000.**--Maximum discharge, 31,000 ft<sup>3</sup>/s Oct. 9, 1977, gage height, 15.5 ft, from rating curve extended above 1,660 ft<sup>3</sup>/s on basis of slope-area measurement of peak flow; no flow at times in most years.

**EXTREMES FOR CURRENT YEAR.**--Peak discharges greater than base discharge of 2,000 ft<sup>3</sup>/s and (or) maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
July 15.....	2030	*1,180	*4.44

Minimum daily discharge, no flow for many days.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.9	0.00
14	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.3	0.00
15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	e55	0.00	0.00
16	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	0.06	0.00
17	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
18	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.2	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.6	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
30	0.00	0.00	0.00	0.00	---	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	---	0.00	0.00	---	0.00	---	0.00	---	0.00	0.00	---
TOTAL	12.51	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	134.30	6.69	0.00
MEAN	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.33	0.22	0.00
MAX	11	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	4.9	0.00
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AC-FT	25	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	266	13	0.00
CFSM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
IN.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1914 - 2004, BY WATER YEAR (WY)

	MEAN	26.5	10.1	33.0	39.0	31.8	23.0	7.75	1.76	1.27	38.5	82.5	24.7
MAX	904	164	542	452	370	318	58.1	16.8	24.4	254	745	158	
(WY)	1978	2001	1979	1979	1985	1983	1992	1983	1984	1950	1955	1983	
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	
(WY)	1914	1919	1919	1974	1974	1914	1914	1914	1914	1918	1991	1918	

## SUMMARY STATISTICS

## FOR 2003 CALENDAR YEAR

## FOR 2004 WATER YEAR

## WATER YEARS 1914 - 2004

ANNUAL TOTAL	484.74	153.60	
ANNUAL MEAN	1.33	0.42	26.0
HIGHEST ANNUAL MEAN			123
LOWEST ANNUAL MEAN			0.42
HIGHEST DAILY MEAN	99	Aug 26	1979
LOWEST DAILY MEAN	0.00	Jan 1	2004
ANNUAL SEVEN-DAY MINIMUM	0.00	Jan 1	1977
ANNUAL RUNOFF (AC-FT)	961	305	13200
ANNUAL RUNOFF (CFSM)	0.002	0.001	0.00
ANNUAL RUNOFF (INCHES)	0.03	0.01	0.00
10 PERCENT EXCEEDS	0.13	0.00	0.66
50 PERCENT EXCEEDS	0.00	0.00	41
90 PERCENT EXCEEDS	0.00	0.00	2.0
			0.00

a Estimated



2004 Water Year  
Santa Cruz River Basin

09480500 SANTA CRUZ RIVER NEAR NOGALES, AZ.

Latitude: 31° 20' 40"

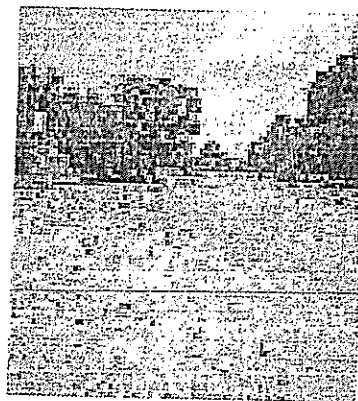
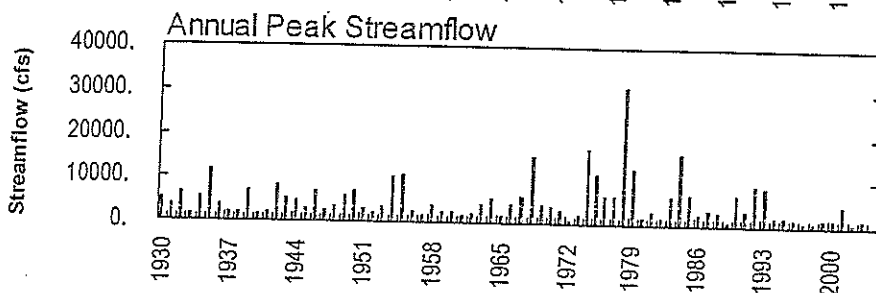
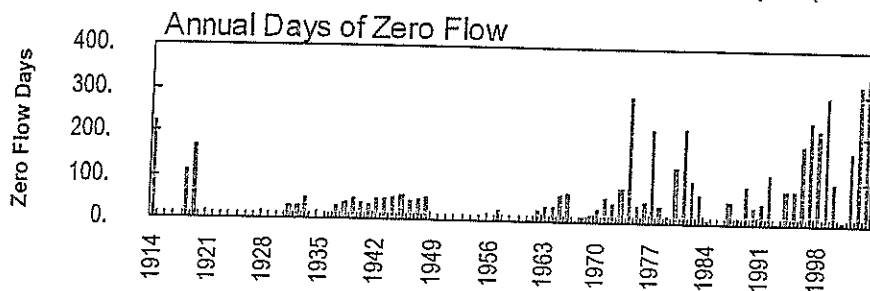
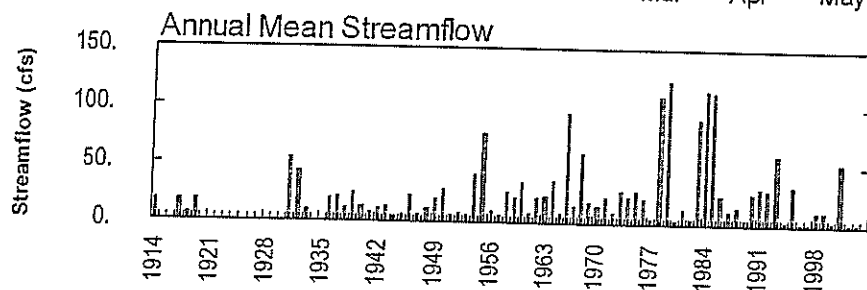
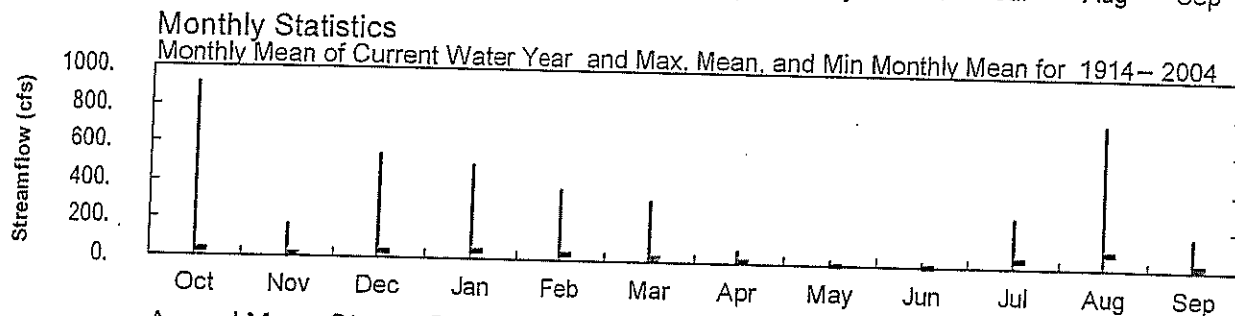
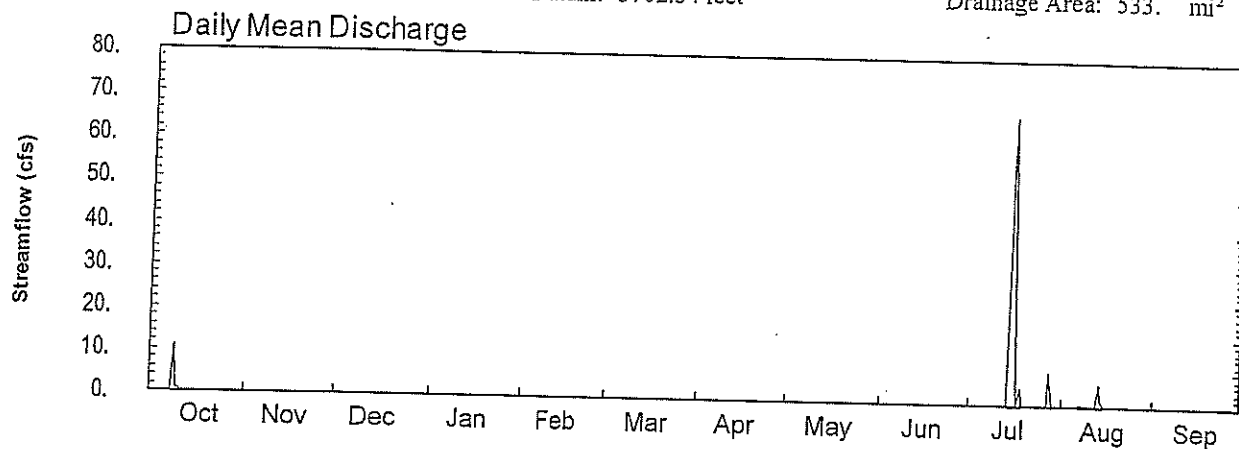
Longitude: 110° 51' 03"

Hydrologic Unit Code: 15050301

Santa cruz County

Datum: 3702.54 feet

Drainage Area: 533. mi<sup>2</sup>



## GILA RIVER BASIN

195

## 09481740 SANTA CRUZ RIVER AT TUBAC, AZ

**LOCATION.**--Lat 31°36'46", long 111°02'27", in SE 1/4 SW 1/4 SW 1/4, sec. 8 T.21 S., R.13 E., Tubac quadrangle, Hydrologic Unit 15050301 in Spanish land grant of San Ignacio de la Canea, on right bank at the Bridge Street bridge, 1/4 mi east of Tubac, 3.1 mi downstream from Tumacacori, and 19 mi south of Continental.

**DRAINAGE AREA.**--1,209 mi<sup>2</sup> of which 395 mi<sup>2</sup> is in Mexico.

**PERIOD OF RECORD.**--Oct. 1995 to current year.

**REVISED RECORDS.**--WRD AZ: 1997.

**GAGE.**--Water-stage recorder. Elevation of gage is 3,180 ft above sea level, from topographic map.

**REMARKS.**--Records fair, except for estimated daily discharges which are poor. Base flow is regulated by sewage-treatment plant at Rio Rico. No natural flow for most of each year.

**EXTREMES FOR PERIOD OF RECORD.**--Maximum discharge, 10,600 ft<sup>3</sup>/s, Oct. 23, 2000, gage height 26.56 ft; minimum daily, 0.15 ft<sup>3</sup>/s, June 26, 1997.

**EXTREMES FOR CURRENT YEAR.**--Peak discharges greater than base discharge of 2,000 ft<sup>3</sup>/s and maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)	Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
July 8 .....	1730	*4,240	24.11	Aug. 15 .....	1430	2,750	23.30
July 23 .....	1645	2,340	23.02				

Minimum daily discharge, 0.51 May 31.

## DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004

## DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.5	e8.3	e17	e151	e20	18	15	7.2	0.63	8.0	e7.6	e11
2	3.3	e8.2	e17	e18	e20	18	16	13	2.1	7.5	e7.7	e11
3	4.4	e10	e17	e18	e20	17	398	12	2.5	7.3	e7.5	e11
4	5.0	e11	e17	e18	e20	19	12	9.8	2.6	6.1	e7.6	e11
5	4.6	e10	e17	e18	e20	16	12	8.8	2.8	3.3	e7.5	e11
6	7.6	e12	e17	e18	21	15	10	5.5	3.1	3.4	105	e10
7	6.7	e13	e17	e19	21	16	11	7.4	3.4	3.3	e15	e10
8	8.7	e13	e17	e19	21	15	11	7.3	4.7	e369	e14	e10
9	147	e14	e17	e19	20	15	11	7.6	5.6	e8.9	e7.5	e10
10	7.3	e18	e17	e19	21	15	12	6.2	6.2	e11	e7.5	e10
11	1.5	e20	e17	e19	22	15	12	7.3	8.0	e7.5	e7.5	e10
12	3.8	e18	e17	e19	21	14	12	7.1	7.6	e7.6	e7.6	e10
13	3.1	64	e17	e19	20	15	12	7.9	7.9	e7.5	e46	e10
14	4.4	16	e17	e19	20	15	12	3.6	7.2	e7.7	e133	e10
15	3.9	16	e18	e19	19	14	13	5.7	7.9	e35	e182	e10
16	4.3	e21	e24	e19	19	15	13	4.6	8.4	141	171	e10
17	2.5	e21	29	e19	19	14	13	4.4	7.6	14	43	e10
18	2.9	e20	e18	e19	18	14	14	4.2	8.0	e8.0	e11	e9.7
19	0.98	e20	e18	e19	18	14	14	2.7	8.1	e67	e11	e9.7
20	0.69	e20	e18	e19	19	14	16	3.2	8.2	31	e11	e9.5
21	2.0	e20	e18	e19	19	14	16	6.3	8.5	e7.8	e11	e9.5
22	5.1	e21	e18	e20	20	14	16	7.7	9.3	e7.5	e11	e9.5
23	5.9	e20	e18	e19	21	13	15	9.5	13	e189	e11	e9.5
24	6.1	e20	e18	e19	21	13	11	9.7	13	30	e11	e9.5
25	5.8	e20	e18	e19	19	13	7.6	8.2	12	e11	e11	e9.5
26	5.1	e20	e18	e19	19	13	12	8.1	12	e7.7	e11	e9.4
27	5.1	e22	e18	e19	19	13	13	9.4	14	e7.7	e11	e9.4
28	5.8	e20	e18	e19	20	13	9.9	4.9	12	e7.6	e11	e9.5
29	7.5	e22	e18	e19	19	13	10	6.9	13	125	e11	e9.3
30	8.0	e20	e18	e20	---	13	13	4.7	11	e8.8	e11	e9.0
31	e7.9	---	e18	e20	---	14	---	0.51	---	e7.5	e11	---
TOTAL	291.47	558.5	561	719	576	454	764.5	211.41	230.33	1153.7	931.0	298.0
MEAN	9.40	18.6	18.1	23.2	19.9	14.6	25.5	6.82	7.68	37.2	30.0	9.93
MAX	147	64	29	151	22	19	398	13	14	369	182	11
MIN	0.69	8.2	17	18	18	13	7.6	0.51	0.63	3.3	7.5	9.0
AC-FT	578	1110	1110	1430	1140	901	1520	419	457	2290	1850	591

## STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1996 - 2004, BY WATER YEAR (WY)

	MEAN	101	47.2	28.8	29.5	31.8	25.1	24.6	9.85	7.21	29.9	39.2	23.5
MAX	798	278	91.1	77.5	67.8	45.4	68.7	29.2	22.4	62.8	60.9	69.1	
(WY)	2001	2001	2001	2001	1998	1998	2001	2001	2000	1998	2003	1999	
MIN	2.89	8.57	16.1	14.6	19.0	14.6	8.73	3.15	0.12	2.24	22.1	9.93	
(WY)	2003	1998	2003	2003	2003	2004	1997	2002	2003	1997	1996	2004	

## SUMMARY STATISTICS

## FOR 2003 CALENDAR YEAR

## FOR 2004 WATER YEAR

## WATER YEARS 1996 - 2004

ANNUAL TOTAL	6534.44	6748.91	
ANNUAL MEAN	17.9	18.4	34.8
HIGHEST ANNUAL MEAN			127
LOWEST ANNUAL MEAN			15.6
HIGHEST DAILY MEAN	479	398	7510
LOWEST DAILY MEAN	0.00	0.51	0.00
ANNUAL SEVEN-DAY MINIMUM	0.00	2.0	0.00
ANNUAL RUNOFF (AC-FT)	12960	13390	25200
10 PERCENT EXCEEDS	22	20	47
50 PERCENT EXCEEDS	13	12	17
90 PERCENT EXCEEDS	0.00	5.1	3.8

e Estimated



2004 Water Year  
Santa Cruz River Basin

09481740 SANTA CRUZ RIVER AT TUBAC, AZ.

Latitude: 31°36'46"

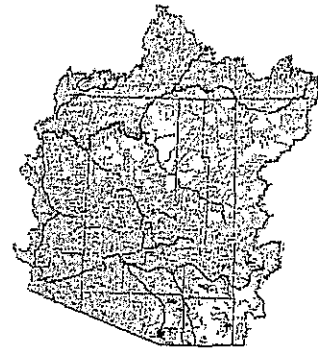
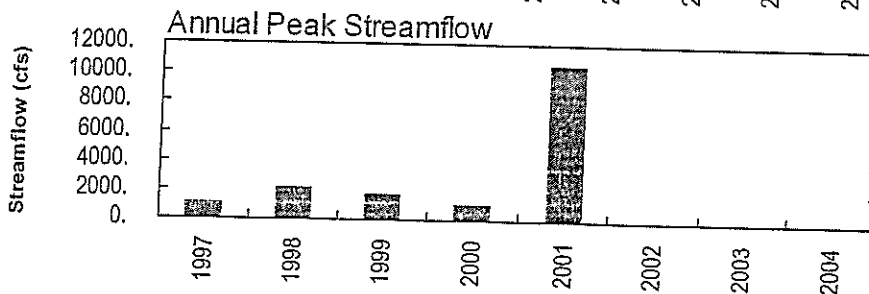
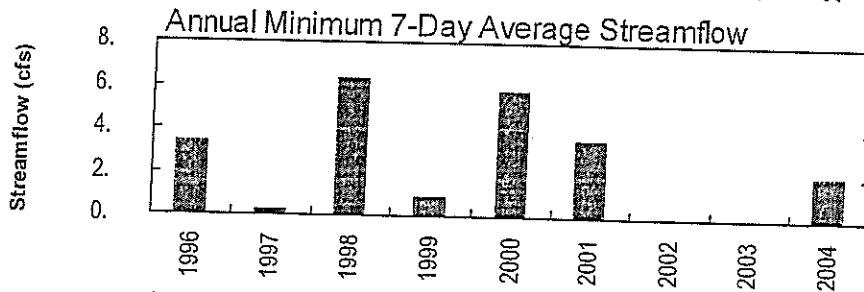
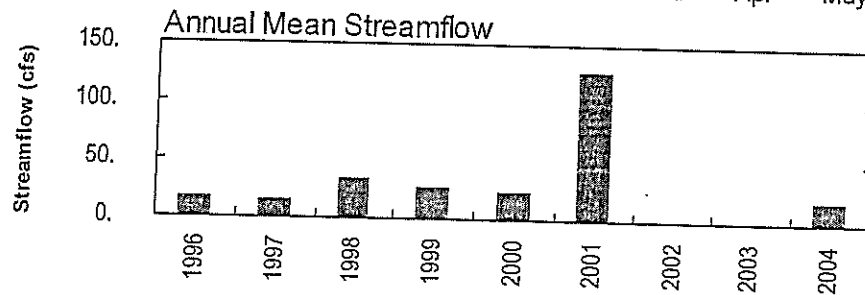
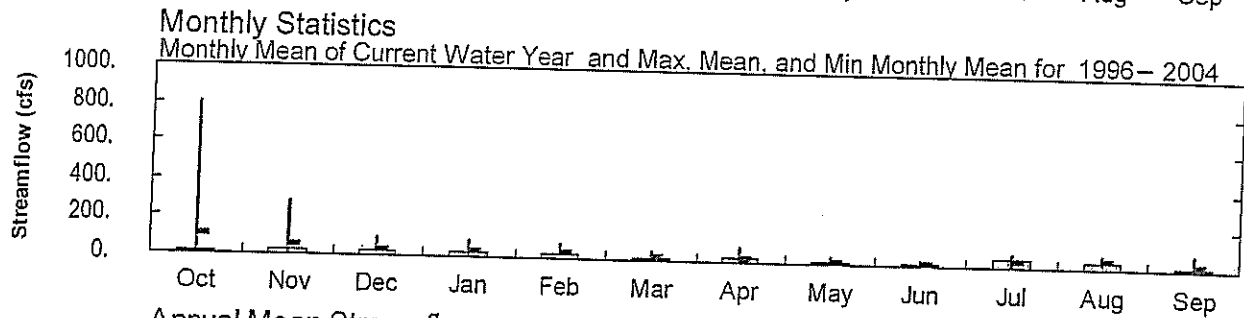
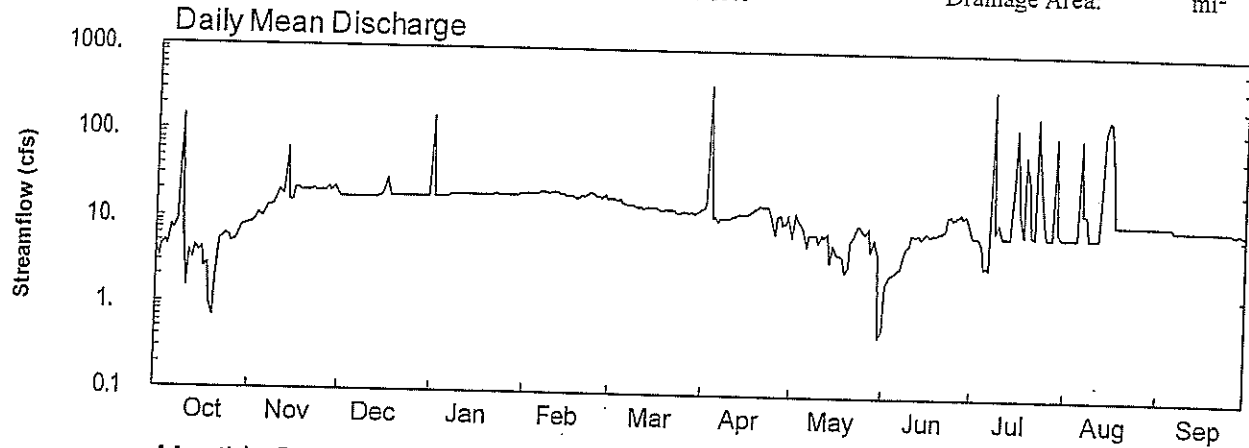
Longitude: 111°02'27"

Santa Cruz County

Datum: 3180 feet

Hydrologic Unit Code: 15050301

Drainage Area: mi<sup>2</sup>





## GILA RIVER BASIN

197

## 09481770 SANTA CRUZ RIVER AT ELEPHANT HEAD ROAD NEAR AMADO, AZ

LOCATION.--Lat 31°44'41.4", long 111°02'11.2", in sec.29, T.19 S., R.10 E. On left bank, upstream side of Elephant Head Road Bridge, 3 miles north of Arivaca Junction, and 5 miles north of Amado, Arizona.

DRAINAGE AREA.--Undetermined.

PERIOD OF RECORD.--Gage established on August 21, 2003. No previous record at this site.

GAGE.--Water-stage recorder. Elevation of gage undetermined.

REMARKS.--Records poor to August 24, fair for the remainder of the water year. Base flow consists of effluent releases from the International Boundary Wastewater Treatment Plant (IBWTP) located in Rio Rico, AZ. The plant is located at the confluence of Nogales Wash and the Santa Cruz River, 25 miles south of the gage. No flow for several months.

EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 1,940 ft<sup>3</sup>/s, Sept. 18, 2004; minimum daily discharge, no flow for several months.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	e0.00	e0.87	9.7	7.0	7.8	4.9	0.41	0.00	0.00	6.8	3.1
2	0.00	e0.00	e1.1	e4.5	7.0	8.8	11	0.92	0.00	0.00	6.4	3.0
3	0.00	e0.00	e1.1	e4.5	7.9	10	44	1.1	0.00	0.00	22	5.1
4	0.00	e0.00	e1.2	e4.5	8.1	13	8.0	1.2	0.00	0.00	9.6	5.8
5	0.00	e0.00	e1.4	e4.5	9.2	11	4.9	1.1	0.00	0.00	e5.3	11
6	0.00	e0.00	e1.4	e4.5	9.4	9.3	2.0	0.93	0.00	0.00	e104	7.8
7	0.00	e0.00	e1.5	e4.6	8.9	9.3	1.7	0.89	0.00	0.00	43	7.5
8	0.00	e0.00	e1.5	e4.6	9.8	8.0	1.6	1.1	0.00	0.00	27	8.0
9	0.00	e0.00	e1.6	e4.6	9.2	7.4	1.8	e0.85	0.00	13	6.7	7.3
10	0.00	e0.00	e1.7	e4.6	11	7.1	1.7	e0.93	0.00	18	25	7.2
11	0.00	e0.00	e1.6	e4.6	9.0	6.3	1.9	0.69	0.00	0.19	12	7.2
12	0.00	e0.00	e1.7	e4.6	9.7	6.8	1.9	0.77	0.00	0.00	6.4	7.5
13	0.00	e0.00	e1.6	3.9	8.2	7.4	2.7	0.90	0.00	0.00	73	7.2
14	0.00	e0.00	e1.6	4.2	8.7	9.1	2.7	0.63	0.00	0.02	92	8.0
15	0.00	e0.00	e1.8	4.7	8.4	7.5	2.7	0.77	0.00	41	7.7	9.6
16	0.00	e0.00	e2.4	4.9	8.6	6.7	2.7	1.1	0.00	149	84	11
17	0.00	e0.00	e2.2	4.7	8.2	5.8	2.6	0.69	0.00	8.5	22	10
18	0.00	e0.00	e2.5	4.7	7.7	4.5	2.5	0.67	0.00	3.2	1.5	91
19	0.00	e0.00	e2.9	5.3	6.9	4.8	2.5	0.73	0.00	0.86	2.6	1.1
20	0.00	e0.00	e3.2	5.3	7.3	5.6	3.3	0.10	0.00	e55	1.7	2.4
21	0.00	e0.00	e3.6	5.5	7.1	5.1	3.5	0.00	0.00	e7.1	1.7	3.0
22	0.00	e0.00	e3.9	6.2	7.5	4.4	2.7	0.00	0.00	e6.3	1.9	3.2
23	0.00	e0.00	e4.1	7.1	7.9	5.0	3.1	0.00	0.00	e36	2.0	3.6
24	0.00	e0.02	e4.3	6.0	8.3	4.6	1.7	0.00	0.00	24	3.2	4.2
25	0.00	e0.06	4.3	5.6	6.8	3.9	1.4	0.00	0.00	2.0	3.4	4.1
26	0.00	e0.20	4.0	4.8	5.6	3.7	1.5	0.00	0.00	1.2	3.5	4.0
27	0.00	e0.29	5.1	5.3	4.6	4.6	1.8	0.00	0.00	16	3.5	4.6
28	0.00	e0.45	e3.9	5.6	6.0	4.6	1.4	0.00	0.00	18	3.8	4.8
29	0.00	e0.52	e5.0	6.0	7.1	4.1	1.2	0.00	0.00	87	3.8	5.5
30	0.00	e0.79	e4.4	6.4	---	4.7	1.0	0.00	0.00	8.0	3.3	5.3
31	0.00	---	4.5	6.9	---	5.0	---	0.00	0.00	7.2	3.2	---
TOTAL	0.00	2.33	e1.97	162.9	231.1	205.9	126.4	16.48	0.00	501.57	592.0	263.1
MEAN	0.06	0.08	2.64	5.25	7.97	6.64	4.21	0.53	0.00	16.2	19.1	8.77
MAX	0.00	0.79	5.1	9.7	11	13	44	1.2	0.00	149	104	91
MIN	0.00	0.00	0.87	3.9	4.6	3.7	1.0	0.00	0.00	0.00	1.5	1.1
MED	0.00	0.00	2.2	4.7	8.1	6.3	2.5	0.69	0.00	3.2	6.4	5.7
AC-FT	0.00	4.6	163	323	458	408	291	33	0.00	995	1170	522

## STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 2003 - 2004, BY WATER YEAR (WY)

	MEAN	0.00	0.08	2.64	5.25	7.97	6.64	4.21	0.53	0.00	16.2	19.1	8.77
MAX	0.00	0.08	2.64	5.25	7.97	6.64	4.21	0.53	0.00	16.2	19.1	8.77	
(WY)	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	
MIN	0.00	0.08	2.64	5.25	7.97	6.64	4.21	0.53	0.00	16.2	19.1	8.77	
(WY)	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	

## SUMMARY STATISTICS

## FOR 2004 WATER YEAR

## WATER YEARS 2003 - 2004

ANNUAL TOTAL	2183.75	
ANNUAL MEAN	5.97	
HIGHEST ANNUAL MEAN	5.97	2004
LOWEST ANNUAL MEAN	5.97	2004
HIGHEST DAILY MEAN	149	Jul 16
LOWEST DAILY MEAN	0.00	Oct 1
ANNUAL SEVEN-DAY MINIMUM	0.00	Oct 1
ANNUAL RUNOFF (AC-FT)	4330	0.00 Oct 1 2003
10 PERCENT EXCEEDS	9.3	4320
50 PERCENT EXCEEDS	2.7	9.3
90 PERCENT EXCEEDS	0.00	2.7
		0.00

e Estimated



2004 Water Year  
Santa Cruz River Basin

09481770 SANTA CRUZ NR AMADO

Latitude: 31°44'41"

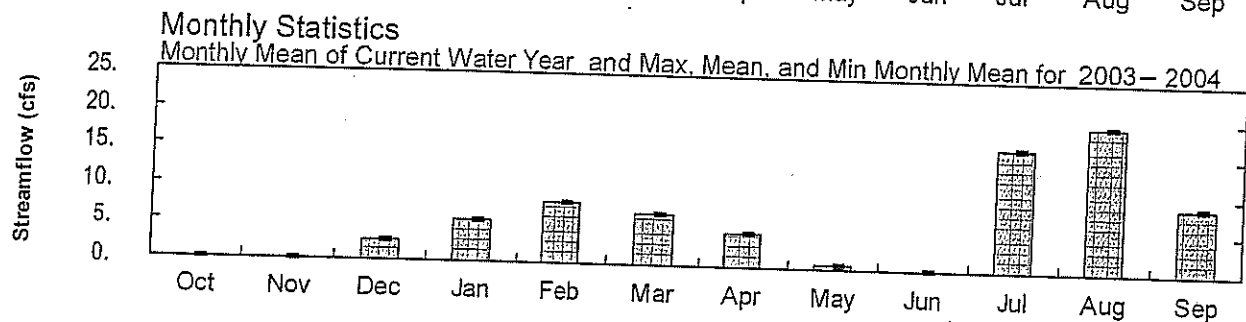
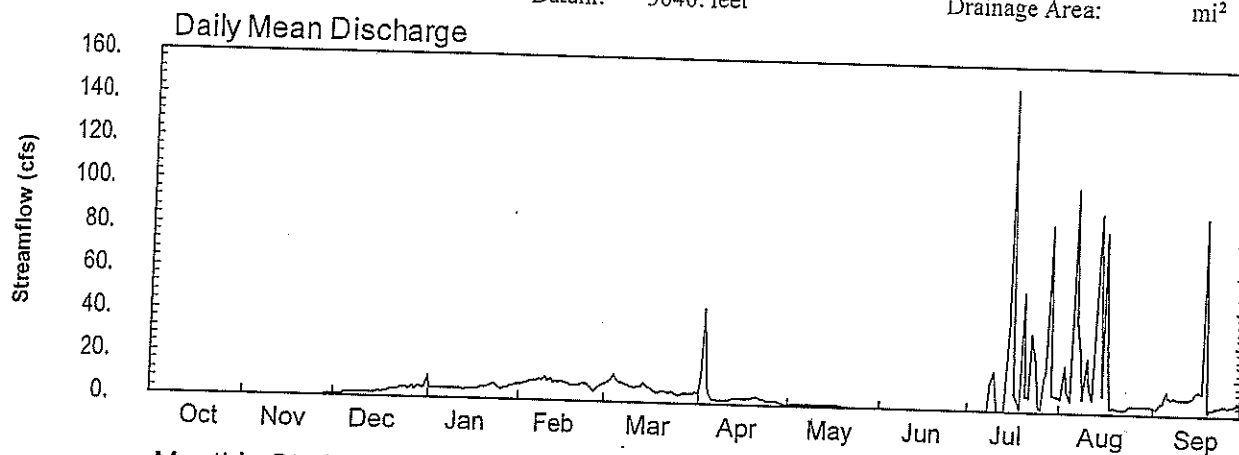
Longitude: 111°02'11"

Pima County

Datum: 3040. feet

Hydrologic Unit Code: 15050301

Drainage Area: mi<sup>2</sup>



## GILA RIVER BASIN

199

## 09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ

**LOCATION.**--Lat 31°52'17", long 110°58'46", in SE¼SE¼ sec. 11, T.18 S., R.13 E. (unsurveyed), Pima County, Hydrologic Unit 15050301, in Spanish land grant of San Ignacio de la Canoa, on right bank 0.8 mi northeast of Green Valley Post Office, and 1.5 mi north of Continental. Prior to Feb. 13, 1981, at site 1.5 mi upstream.

**DRAINAGE AREA.**--1,682 mi<sup>2</sup>, of which 395 mi<sup>2</sup> is in Mexico.

**PERIOD OF RECORD.**--May 1940 to Dec. 1946, Oct. 1951 to Sept. 1984, Oct. 1991 to current year (monthly discharge only for 1985--86), (crest-stage partial record station for 1987--1990). Low-flow records not equivalent prior to Feb. 13, 1981, owing to undetermined amount of underflow between sites.

**REVISED RECORDS.**--WSP 1283: Drainage area. WDR AZ-81-1: Drainage area.

**GAGE.**--Water-stage recorder. Datum of gage is 2,806.61 ft above sea level. Prior to Feb. 13, 1981, at site 1.5 mi upstream. July 21, 1940 to Sept. 8, 1965 at datum 17.28 ft higher; Sept. 8, 1965 to present at datum 13.21 ft higher. Old site used as supplementary gage until Oct. 29, 1985.

**REMARKS.**--Records poor. Irrigation above station of about 12,500 acres including about 2,300 acres in Mexico, mostly by pumping ground water.

**EXTREMES FOR PERIOD OF RECORD.**--Maximum discharge, 45,000 ft<sup>3</sup>/s Oct. 2, 1983, gage height, 16.34 ft from rating curve extended above 530 ft<sup>3</sup>/s on basis of slope-area measurement at gage height 7.75 ft and slope-area measurement of peak flow, maximum gage height 16.70 ft Oct. 9, 1977, site and datum then in use; no flow for most of each year.

**EXTREMES FOR CURRENT YEAR.**--Peak discharges greater than base discharge of 2,000 ft<sup>3</sup>/s and (or) maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
Sept. 18,.....	2115	*541	*4.18

Minimum daily discharge, no flow for most of year.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	2.7	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4	0.60	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.8	2.5	0.00
12	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	1.1	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.1	28	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.3	87	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.5	0.42	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89	49	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20	21	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	48
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.0
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	8.2	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24	0.01	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.7	0.00	0.00
30	0.00	0.00	0.00	0.00	---	0.00	0.00	0.00	0.00	54	0.00	0.00
31	0.00	---	0.00	0.00	---	0.00	---	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.09	0.00	0.01	0.00	0.00	0.49	0.00	0.00	244.44	262.39	50.00
MEAN	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	7.89	8.46	1.67
MAX	0.00	0.09	0.00	0.01	0.00	0.00	0.22	0.00	0.00	89	87	48
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AC-FT	0.00	0.2	0.00	0.02	0.00	0.00	1.0	0.00	0.00	485	520	99

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1941 - 2004, BY WATER YEAR (WY)

	MEAN	50.8	5.31	33.8	44.0	11.7	9.96	0.70	0.03	0.40	28.6	75.9	17.9
MAX	1525	133	658	1386	207	181	31.5	1.32	6.18	227	753	285	
(WY)	1984	1979	1968	1993	1966	1983	1992	1992	1978	1954	1955	1964	
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
(WY)	1943	1941	1942	1942	1942	1941	1941	1941	1941	1993	1956	1953	

## SUMMARY STATISTICS

## FOR 2003 CALENDAR YEAR

## FOR 2004 WATER YEAR

## WATER YEARS 1941 - 2004

ANNUAL TOTAL	703.92	557.42	
ANNUAL MEAN	1.93	1.52	23.5
HIGHEST ANNUAL MEAN			206
LOWEST ANNUAL MEAN			0.26
HIGHEST DAILY MEAN	362	Jul 28	89
LOWEST DAILY MEAN	0.00	Jan 1	0.00
ANNUAL SEVEN-DAY MINIMUM	0.00	Jan 1	0.00
ANNUAL RUNOFF (AC-FT)	1400		1110
10 PERCENT EXCEEDS	0.00		0.03
50 PERCENT EXCEEDS	0.00		0.00
90 PERCENT EXCEEDS	0.00		0.00



2004 Water Year  
Santa Cruz River Basin

09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ

Latitude: 31° 52' 17"

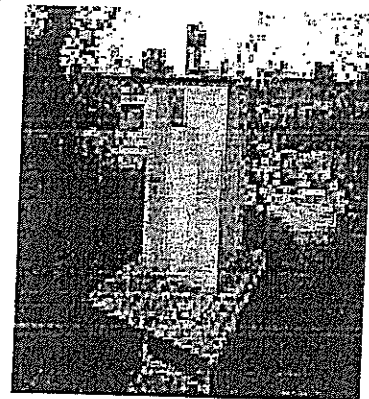
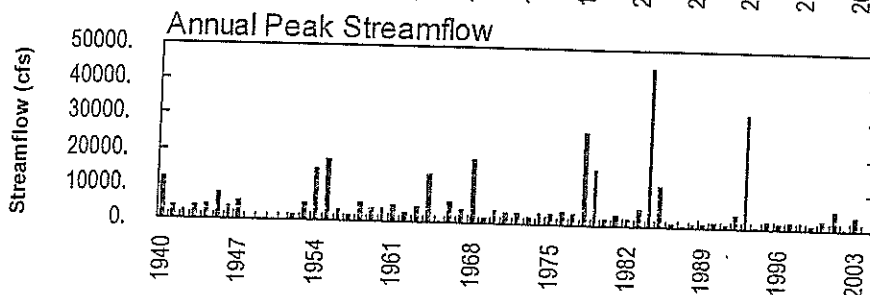
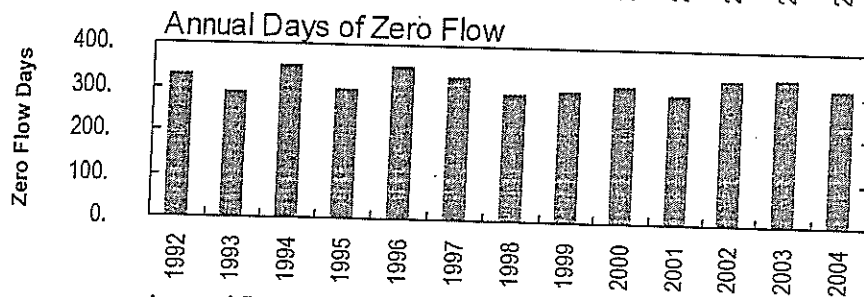
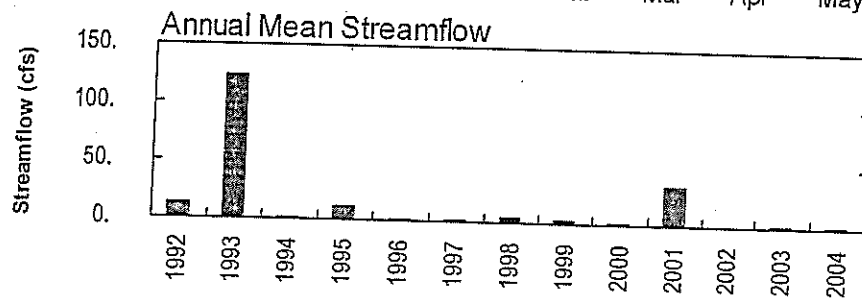
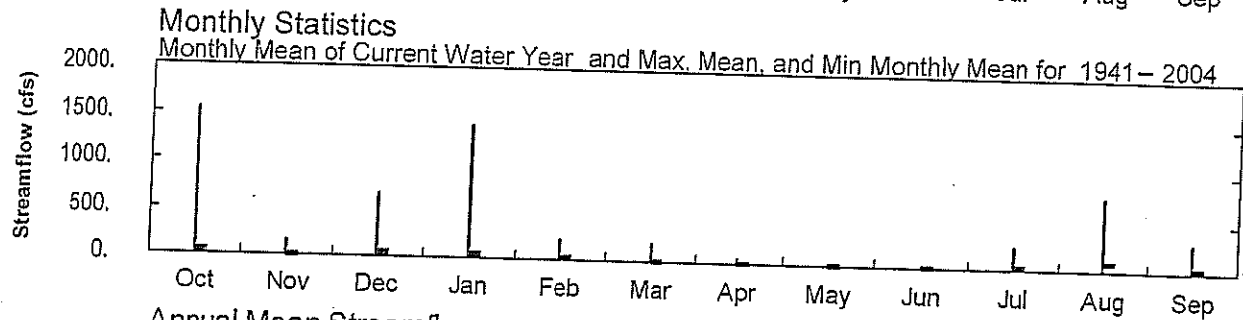
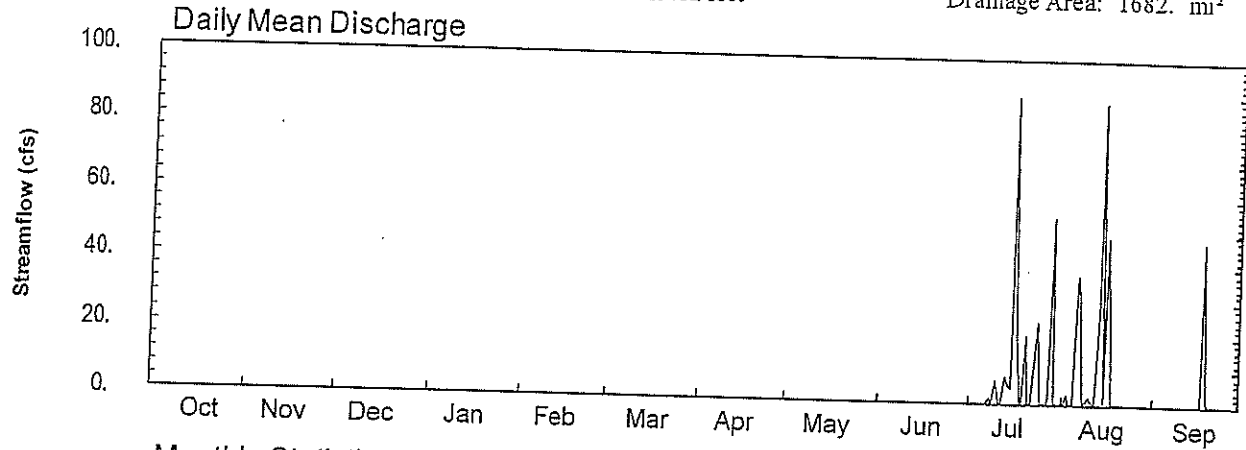
Longitude: 110° 58' 46"

Pima County

Datum: 2819.82 feet

Hydrologic Unit Code: 15050301

Drainage Area: 1682. mi<sup>2</sup>



## GILA RIVER BASIN

201

## 09482500 SANTA CRUZ RIVER AT TUCSON, AZ

**LOCATION.**--Lat 32°13'19", long 110°58'52", in SE1/4SE1/4 sec. 11, T.14 S., R.13 E., Pima County, Hydrologic Unit 15050301, on right bank, 300 ft downstream from Congress Street Bridge, in Tucson.

**DRAINAGE AREA.**--2,222 mi<sup>2</sup>, of which 395 mi<sup>2</sup> is in Mexico, adjusted for 15.2 mi<sup>2</sup> of Tucson Arroyo drainage area contributing to this station effective July 1956.

**PERIOD OF RECORD.**--Oct. 1905 to Sept. 1981 (monthly discharge only, Jan. 1907 to Sept. 1912, Jan. to Sept. 1914), June 1986 to Sept. 1995 (discharge above 500 ft<sup>3</sup>/s only), Oct. 1995 to current year.

**REVISED RECORDS.**--WSP 859: 1915(M). WSP 1283: Drainage area. WSP 1313: 1939(M). WDR AZ-88-1: 1986-87(M).

**GAGE.**--Water-stage recorder and crest-stage gage. Datum of gage is 2,320.68 ft above sea level. Prior to Nov. 27, 1929, nonrecording gages or reference points for measuring to water surface at various places on Congress Street bridge at various datums. Nov. 27, 1929 to Sept. 30, 1981, water-stage recorder at Congress Street bridge: at datum 6.22 ft higher Nov. 27, 1929 to June 18, 1958; at datum 2.22 ft higher June 18, 1958 to May 21, 1983; at datum 3.48 ft lower May 21, 1963 to Oct. 27, 1970; at datum 2.86 ft lower Oct. 1, 1971, to Sept. 30, 1981. No gage Oct. 27, 1970 to Oct. 1, 1971, and Oct. 10, 1977, to Feb. 14, 1978.

**REMARKS.**--Records fair, except for estimated daily discharges, which are poor. Irrigation above station of about 26,000 acres, including about 2,300 acres in Mexico, mostly by pumping from ground water. Ground water is also pumped above the station for municipal supply and mining. From Oct. 1969 to Sept. 1981, all flow past station was published, including waste water when known.

**EXTREMES FOR PERIOD OF RECORD.**--Maximum discharge, 37,400 ft<sup>3</sup>/s Jan. 19, 1993, gage height, 11.67 ft; no flow for most of each year.

**EXTREMES OUTSIDE PERIOD OF RECORD.**--Maximum discharge since at least 1892, 52,700 ft<sup>3</sup>/s, from slope-area measurement of peak flow, Oct. 2, 1983; gage height, 22.2 ft, from floodmark, at site and datum used in 1981.

Maximum discharge during the 1985 water year was 10,000 ft<sup>3</sup>/s Dec. 28, 1984; gage height, 12.5 ft, at site and datum used in 1981.

**EXTREMES FOR CURRENT YEAR.**--Peak discharges greater than base discharge of 1,700 ft<sup>3</sup>/s and (or) maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
July 18.....	0300	1,900	3.99
Sept. 18.....	1520	*3,330	*4.89

Minimum daily discharge, no flow for most of year.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	0.00	0.00	0.00	0.00	0.00	1.9	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	74	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	5.6	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	21	27	0.00	0.00	0.00	0.00	50
5	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	162
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	3.1	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	---	0.00	0.00	---	2.6	---	0.00	0.00	0.00	0.00	0.00
TOTAL	16.79	126.00	0.00	16.92	1.50	23.60	108.71	0.00	0.00	576.91	34.08	548.00
MEAN	0.54	4.20	0.00	0.55	0.05	0.76	3.62	0.00	0.00	18.6	1.10	18.3
MAX	15	82	0.00	13	1.5	21	74	0.00	0.00	144	34	257
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MED	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AC-FT	33	250	0.00	34	3.0	47	216	0.00	0.00	1140	68	1090
CFSM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1997 - 2004, BY WATER YEAR (WY)

	MEAN	59.5	14.9	0.05	1.63	0.42	0.70	1.46	0.20	3.17	24.1	21.2	13.0
MAX	356	85.0	0.19	9.23	1.24	2.73	3.63	1.20	18.6	84.2	49.7	43.9	
(WY)	2001	2001	2002	2001	2003	2001	1999	2003	2000	1999	2003	2003	2002
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.77	1.10	0.00
(WY)	1999	2000	2000	1999	2001	2002	2000	1999	1999	2001	2004	2001	

SUMMARY STATISTICS

	FOR 2003 CALENDAR YEAR	FOR 2004 WATER YEAR	WATER YEARS 1997 - 2004
ANNUAL TOTAL	2393.57	1452.51	
ANNUAL MEAN	6.56	3.97	12.0
HIGHEST ANNUAL MEAN			39.0
LOWEST ANNUAL MEAN			3.97
HIGHEST DAILY MEAN	421	257	7360
LOWEST DAILY MEAN	0.00	0.00	0.00
ANNUAL SEVEN-DAY MINIMUM	0.00	0.00	0.00
ANNUAL RUNOFF (AC-FT)	4750	2880	8690
ANNUAL RUNOFF (CFSM)	0.003	0.002	0.005
10 PERCENT EXCEEDS	0.28	0.11	0.80
50 PERCENT EXCEEDS	0.00	0.00	0.00
90 PERCENT EXCEEDS	0.00	0.00	0.00



2004 Water Year  
Santa Cruz River Basin

09482500 SANTA CRUZ RIVER AT TUCSON, AZ.

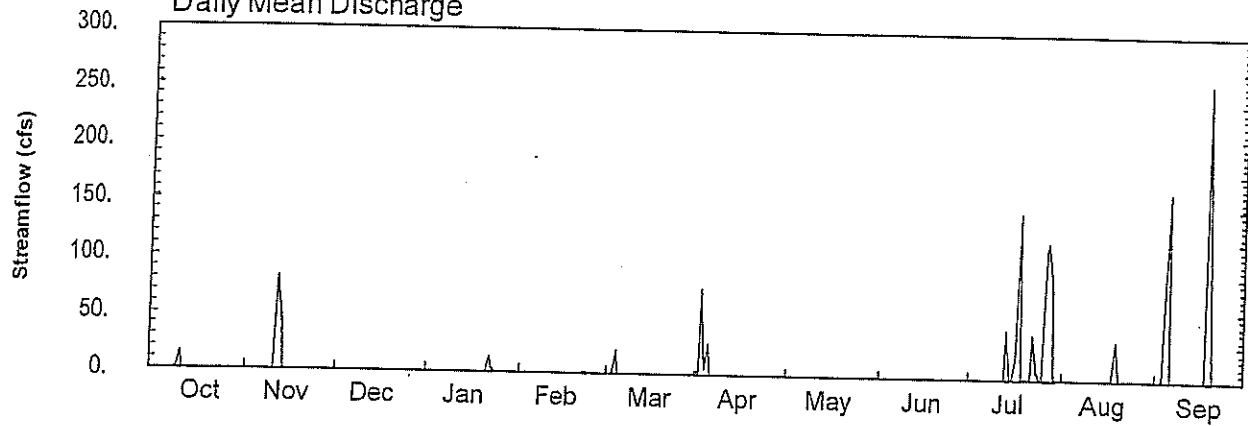
Latitude: 32° 13' 16"  
Pima County

Longitude: 110° 58' 52"

Datum: 2317.14 feet

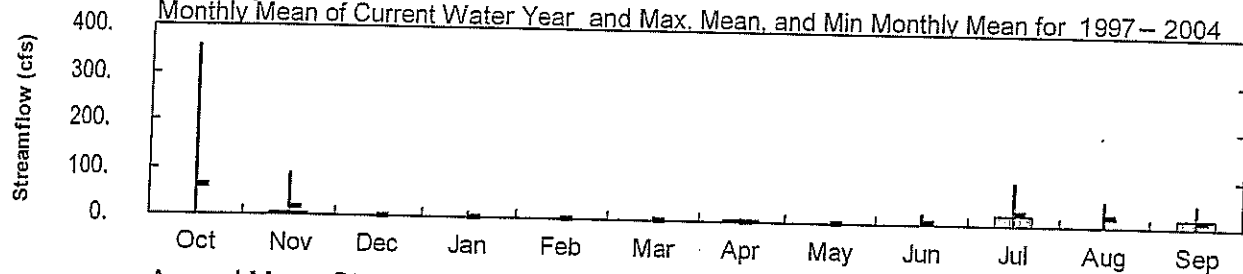
Hydrologic Unit Code: 15050301  
Drainage Area: 2222. mi<sup>2</sup>

Daily Mean Discharge

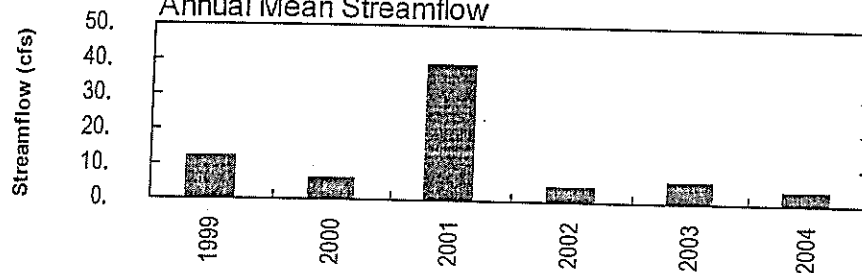


Monthly Statistics

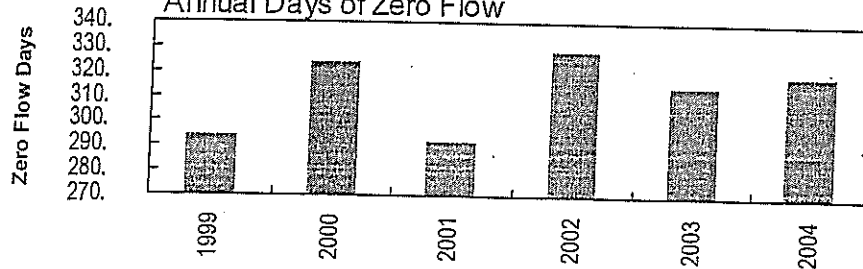
Monthly Mean of Current Water Year and Max. Mean, and Min Monthly Mean for 1997-2004



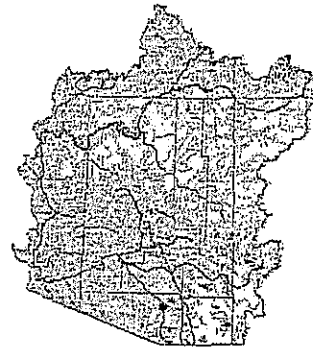
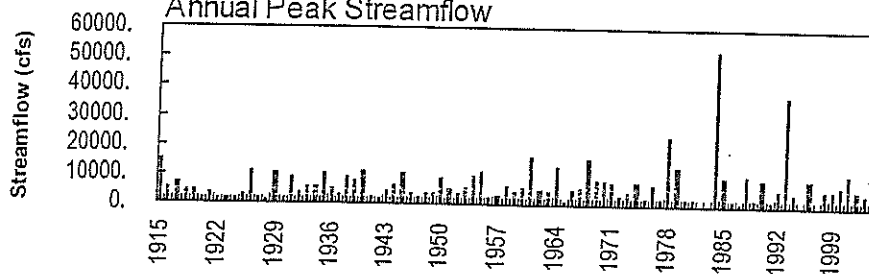
Annual Mean Streamflow



Annual Days of Zero Flow



Annual Peak Streamflow



## GILA RIVER BASIN

221

## 09486500 SANTA CRUZ RIVER AT CORTARO, AZ

**LOCATION.**--Lat 32°21'04", long 111°05'38", in NW¼NW¼NW¼ sec. 35, T.12 S., R.12 E., Pima County, Hydrologic Unit 15050302, at center column of bridge pier on left bank, 0.5 mi southwest of Cortaro, 1 mi downstream from Ina Road treatment plant, 2.6 mi downstream from Canada del Oro, and 3.7 mi downstream from Rillito Creek.

**DRAINAGE AREA.**--3,503 mi<sup>2</sup>, of which 395 mi<sup>2</sup> is in Mexico.

**PERIOD OF RECORD.**--Oct. 1939 to June 1947 (published as "at Rillito"), July 1950 to Sept. 1984, Mar. to June 1990, July to Sept. 1990 (fragmentary record), Oct. 1990 to current year.

**REVISED RECORDS.**--WSP 1283: Drainage area.

**GAGE.**--Water-stage recorder. Datum of gage is 2,100.00 ft, above sea level. Prior to June 30, 1947, at site 5.5 mi downstream at different datum. July 8, 1950, to Jan. 20, 1966, at present site at datum 19.11 ft lower. Jan. 20, 1966, to Sept. 30, 1984, at present site and datum 23.11 ft lower. Aug. 1 to Oct. 19, 1990, at site on right bank 0.33 mi downstream from bridge at datum 30.20 ft lower. Apr. 10 to May 17, 1991, at site on bridge, 200 ft toward right bank, at different datum. Supplementary water-stage recorder on downstream site on left bridge pier at datum 19.11 ft lower Aug. 29, 1969, to Sept. 30, 1984. Temporary water-stage recorder on right bank Oct. 27, 1983, to Sept. 30, 1984, at datum 20.80 ft lower. Prior to May 8 at site 300 ft upstream at different datum.

**REMARKS.**--Records good, except for estimated daily discharges, which are poor. Many diversions above station, mostly by pumping from ground water, for irrigation of about 34,000 acres. Waste water from irrigation and from sewage-disposal plants is included in flow past station in water years 1951, 1952, 1970-82, 1990-97.

**EXTREMES FOR PERIOD OF RECORD.**--Maximum discharge, 65,000 ft<sup>3</sup>/s Oct. 2, 1983, gage height 16.57 ft from floodmark, computed by flood-routing method from Santa Cruz River at Tucson and Rillito Creek at Tucson; no natural flow for most of each year. (See REMARKS)

**EXTREMES FOR CURRENT YEAR.**--Peak discharges greater than base discharge of 2,700 ft<sup>3</sup>/s and (or) maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
Aug. 14.....	0045	*5,420	*9.25
Sept. 18.....	2100	5,160	9.19

Minimum daily discharge, 55 ft<sup>3</sup>/s on Dec. 25.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	56	63	70	69	80	87	74	73	67	66	69	78
2	65	66	66	81	80	87	181	73	64	65	68	82
3	65	70	64	82	82	83	117	76	70	62	70	81
4	62	66	67	84	82	216	112	76	68	61	71	119
5	60	68	67	81	87	153	90	76	64	61	75	191
6	60	76	64	78	84	149	78	76	60	65	154	75
7	65	73	65	80	87	150	78	79	61	60	74	75
8	68	73	66	79	73	215	80	74	59	63	73	74
9	68	69	65	79	79	156	83	71	63	66	94	73
10	153	72	64	82	76	95	76	70	63	65	98	74
11	78	71	64	82	75	77	77	68	63	63	68	79
12	65	118	67	83	82	73	76	69	62	67	96	80
13	66	483	69	83	80	78	78	75	62	67	500	81
14	66	74	69	75	79	83	75	71	66	86	517	79
15	63	75	67	86	76	75	78	73	62	69	72	79
16	72	70	66	87	81	74	75	73	64	68	66	78
17	70	72	66	88	75	69	79	75	63	82	72	82
18	72	70	66	84	72	77	69	73	664	162	66	776
19	64	69	69	86	77	77	78	68	661	117	107	357
20	69	72	68	83	75	75	74	74	660	69	66	80
21	69	74	68	81	76	72	75	75	667	69	66	77
22	62	70	68	102	76	76	76	68	64	71	66	74
23	70	72	66	97	88	72	77	68	67	85	66	73
24	68	68	67	85	83	74	76	68	70	157	67	72
25	65	68	55	76	76	78	77	68	70	65	72	74
26	63	67	58	79	81	77	80	66	71	64	75	73
27	67	75	67	79	79	74	75	69	64	243	69	74
28	67	64	66	78	94	72	66	69	67	252	68	71
29	63	65	70	82	81	69	73	67	64	148	73	72
30	68	71	69	89	---	70	76	62	66	68	72	74
31	70	---	71	82	---	71	---	66	---	66	68	---
TOTAL	2139	2564	2054	2562	2316	2954	2449	2209	1936	2772	3238	3427
MEAN	69.0	85.5	66.3	82.6	79.9	95.3	81.6	71.3	64.5	89.4	104	114
MAX	153	483	71	102	94	216	151	79	71	252	517	776
MIN	56	63	55	69	72	69	66	62	59	60	66	71
AC-FT	4240	5090	4070	5080	4590	5860	4860	4380	3840	5500	6420	6800
CFSM	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.03

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1940 - 2004, BY WATER YEAR (WY)

	MEAN	MAX	(WY)	MIN	(WY)
1940	51.5	744	1978	0.00	1940
1941	32.2	228	2001	0.00	1943
1942	81.5	1044	1979	0.00	1943
1943	99.0	2495	1993	0.00	1943
1944	49.3	252	1995	0.00	1943
1945	42.0	496	1978	0.00	1940
1946	22.6	104	1998	0.00	1940
1947	21.1	71.3	2004	0.00	1940
1948	22.4	84.9	2000	0.00	1941
1949	76.7	393	1954	1.69	1960
1950	118	868	1955	1.97	1962
1951	62.1	358	1964	0.00	1953

SUMMARY STATISTICS	FOR 2003 CALENDAR YEAR	FOR 2004 WATER YEAR	WATER YEARS 1940 - 2004
ANNUAL TOTAL	34553	30620	
ANNUAL MEAN	94.7	83.7	57.5
HIGHEST ANNUAL MEAN			262
LOWEST ANNUAL MEAN			2.59
HIGHEST DAILY MEAN	1870	776	40000
LOWEST DAILY MEAN	55	55	0.00
ANNUAL SEVEN-DAY MINIMUM	61	62	0.00
ANNUAL RUNOFF (AC-FT)	68540	60730	41630
ANNUAL RUNOFF (CFSM)	0.027	0.024	0.016
10 PERCENT EXCEEDS	81	88	73
50 PERCENT EXCEEDS	71	73	18
90 PERCENT EXCEEDS	64	64	0.00

e Estimated



2004 Water Year  
Santa Cruz River Basin

09486500 SANTA CRUZ RIVER AT CORTARO, AZ.

Latitude: 32° 21' 04"

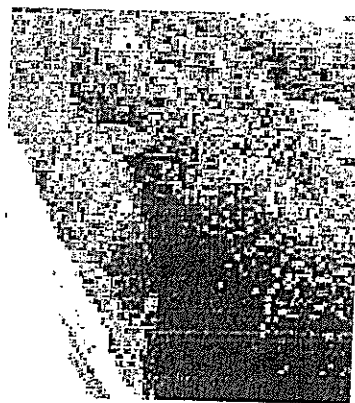
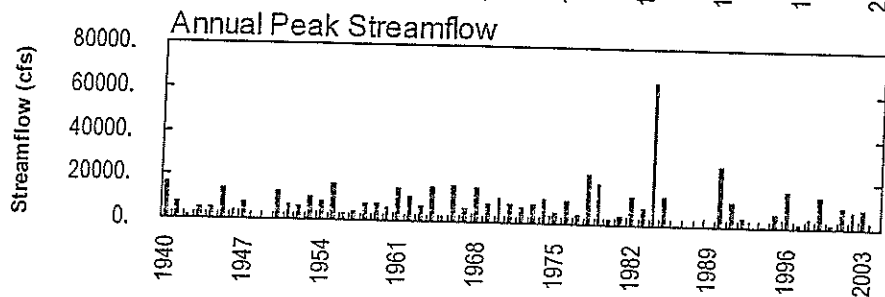
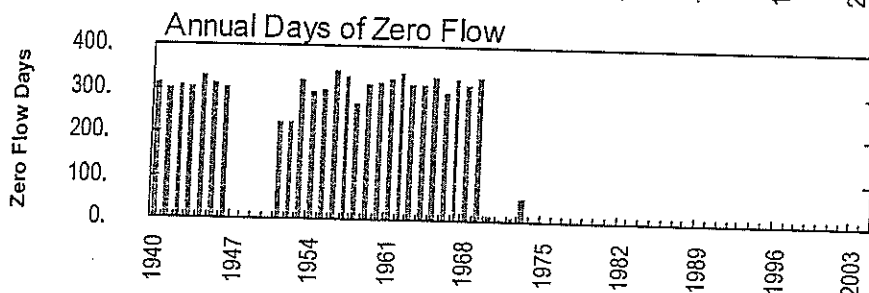
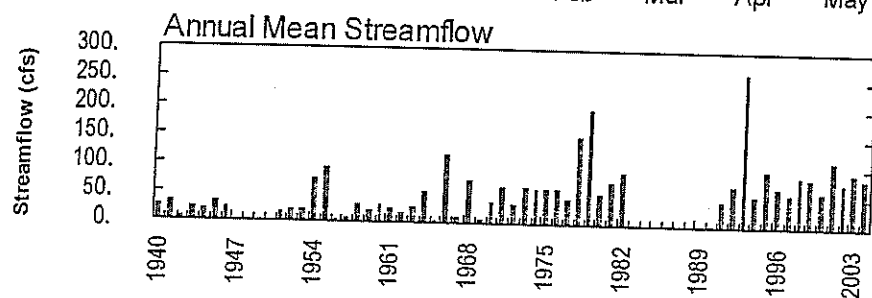
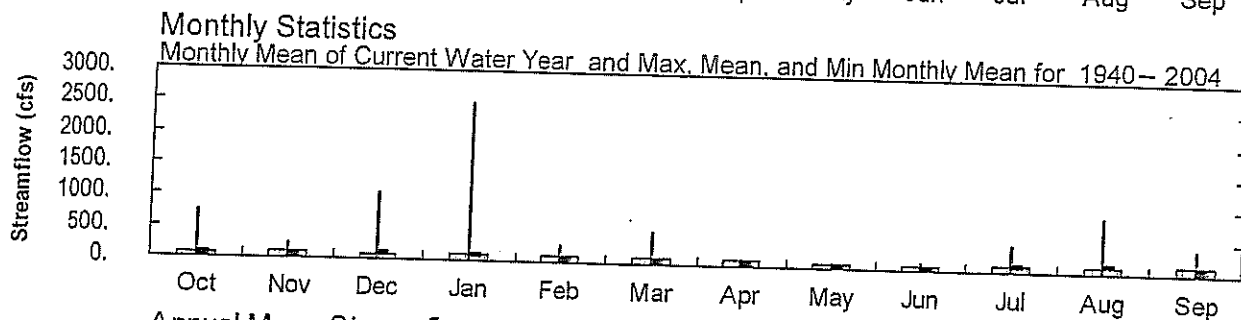
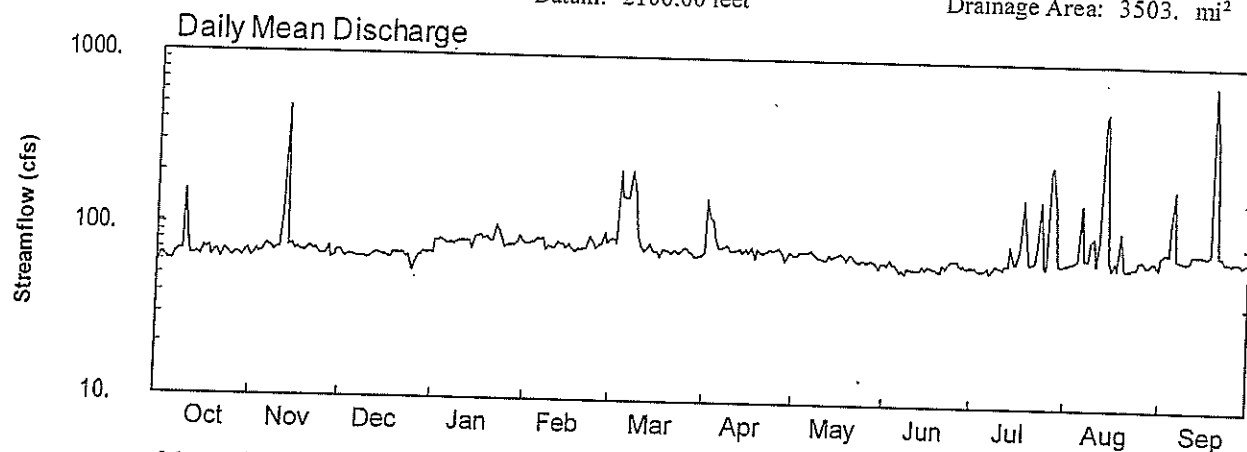
Longitude: 111° 05' 38"

Pima County

Datum: 2100.00 feet

Hydrologic Unit Code: 15050302

Drainage Area: 3503. mi<sup>2</sup>





## GILA RIVER BASIN

223

## 09486520 SANTA CRUZ RIVER AT TRICO ROAD, NEAR MARANA, AZ

LOCATION.—Lat 32°28'17", long 111°18'25", in NE¼SE¼, sec. 15, T.11 S., R.10 E., in Pima County, Hydrologic Unit 15050303, on right bank 750 ft upstream from Trico Road bridge, 5 mi west of Marana, and 24 mi northwest of Tucson.

DRAINAGE AREA.—3,641 mi<sup>2</sup>.

PERIOD OF RECORD.—Apr. 1989 to current year.

GAGE.—Water-stage recorder. Elevation of gage is 1,910 ft above sea level, from topographic map.

REMARKS.—Records good except for estimated daily discharges, which are poor. Base flow is effluent from combined municipal sewage treatment plants at Ina Road, 17.6 mi upstream and Roger Rd., 20 mi upstream.

EXTREMES FOR PERIOD OF RECORD.—Maximum mean daily discharge, 15,000 ft<sup>3</sup>/s Jan. 19, 1993; no flow for many days some years.

EXTREMES FOR CURRENT YEAR.—Peak discharges greater than base discharge of 2,700 ft<sup>3</sup>/s and (or) maximum (\*):

Date	Time	Discharge (ft <sup>3</sup> /s)	Gage height (ft)
Aug. 14.....	0730	*1,780	*7.28

Minimum daily discharge, 20 ft<sup>3</sup>/s, Oct. 15.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004  
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	21	31	46	48	54	57	34	35	31	25	42	42
2	25	33	31	56	62	55	58	34	27	29	51	49
3	32	42	31	60	62	48	114	40	26	21	47	50
4	26	43	30	55	60	94	90	36	32	24	46	60
5	23	36	34	58	58	91	91	33	25	22	46	153
6	30	44	30	53	61	143	59	33	26	28	93	68
7	32	55	33	52	51	107	54	37	27	24	58	65
8	36	48	40	51	46	154	45	31	26	26	49	54
9	36	45	34	49	55	138	54	33	24	29	51	51
10	102	57	33	46	52	74	50	34	26	28	82	50
11	57	48	35	51	45	51	44	32	32	27	49	45
12	43	58	43	59	51	44	48	35	25	36	60	45
13	43	319	41	59	50	42	46	37	27	35	72	54
14	39	79	46	49	42	49	37	39	27	55	548	47
15	20	44	52	62	36	50	43	32	26	47	65	45
16	25	47	44	61	45	40	42	36	25	47	53	46
17	32	53	41	56	45	35	39	43	29	45	54	46
18	29	51	42	59	36	33	34	36	30	111	55	71
19	30	44	41	60	41	38	54	31	26	99	77	432
20	36	44	41	64	45	38	44	29	25	64	55	65
21	35	53	42	56	41	31	42	29	28	42	42	56
22	27	41	46	62	45	40	44	28	25	44	45	51
23	31	44	43	90	59	35	49	26	23	44	51	47
24	37	52	41	53	58	32	42	31	30	104	43	41
25	30	48	38	53	46	38	45	26	32	47	43	35
26	25	39	29	58	44	38	51	27	27	49	48	39
27	38	44	39	53	48	29	46	27	29	146	46	46
28	40	44	42	49	55	32	43	31	28	125	37	41
29	32	38	46	52	49	36	35	29	25	173	38	42
30	34	35	47	58	---	28	47	29	25	51	45	47
31	40	---	48	51	---	29	---	27	---	42	38	---
TOTAL	1086	1659	1229	1743	1444	1749	1524	1006	814	1689	2129	1983
MEAN	35.0	55.3	39.6	56.2	49.8	56.4	50.8	32.5	27.1	54.5	68.7	66.1
MAX	102	319	52	90	62	154	114	43	32	173	548	432
MIN	20	31	29	46	36	28	34	26	23	21	37	35
AC-FT	2150	3290	2440	3460	2860	3470	3020	2000	1610	3350	4220	3930

## STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1990 - 2004, BY WATER YEAR (WY)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MEAN	37.6	26.7	36.6	143	61.1	28.5	17.6	10.8	9.75	45.8	34.3	35.6			
MAX	337	73.0	157	1509	294	82.1	50.8	32.5	27.1	318	141	207			
(WY)	2001	2001	1995	1993	1998	1991	2004	2004	2004	1990	2003	1996			
MIN	0.00	1.76	3.83	9.60	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00			
(WY)	1996	1996	2001	1992	1993	1993	1991	1991	1991	1991	1991	1995			

## SUMMARY STATISTICS

## FOR 2003 CALENDAR YEAR

## FOR 2004 WATER YEAR

## WATER YEARS 1990 - 2004

ANNUAL TOTAL	15905	18055	
ANNUAL MEAN	43.6	49.3	40.6
HIGHEST ANNUAL MEAN			135
LOWEST ANNUAL MEAN			9.71
HIGHEST DAILY MEAN	1210	Aug 27	548
LOWEST DAILY MEAN	11	Jul 8	20
ANNUAL SEVEN-DAY MINIMUM	13	Jul 4	24
ANNUAL RUNOFF (AC-FT)	31550	35810	29450
10 PERCENT EXCEEDS	48	62	44
50 PERCENT EXCEEDS	31	44	15
90 PERCENT EXCEEDS	18	27	0.00



2004 Water Year  
Santa Cruz River Basin

09486520 SANTA CRUZ RIVER AT TRICO ROAD, NR MARANA, AZ.

Latitude: 32° 28 ' 17"

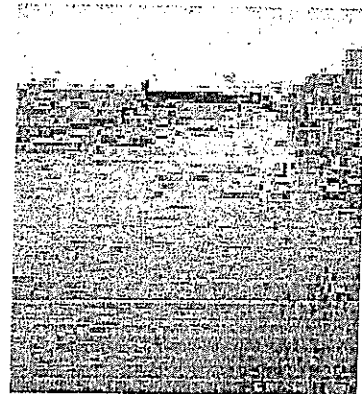
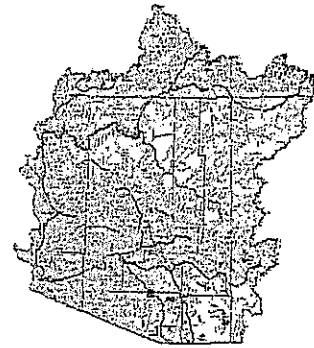
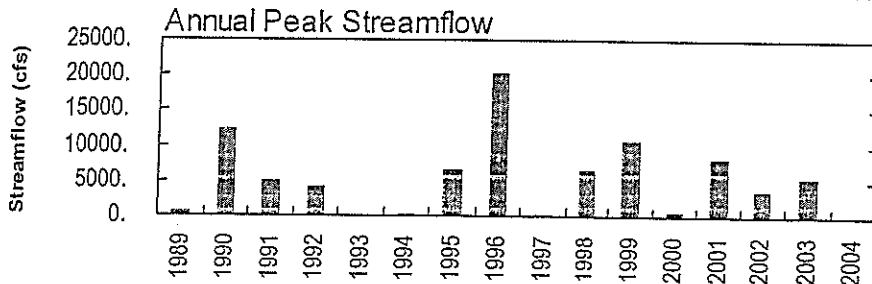
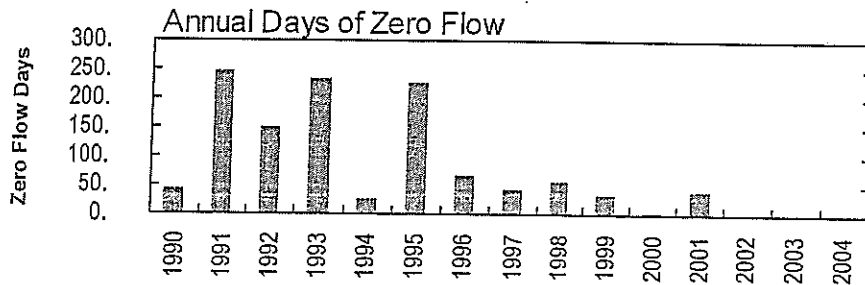
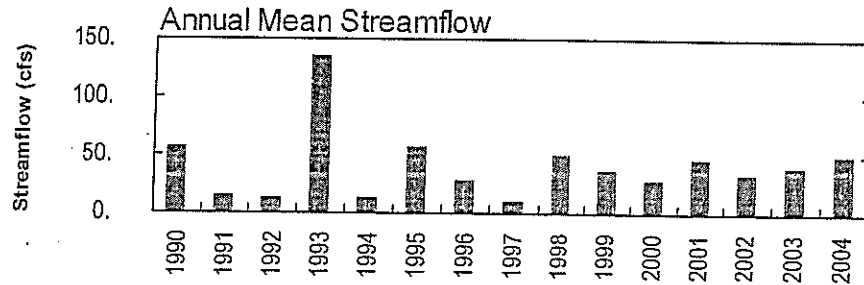
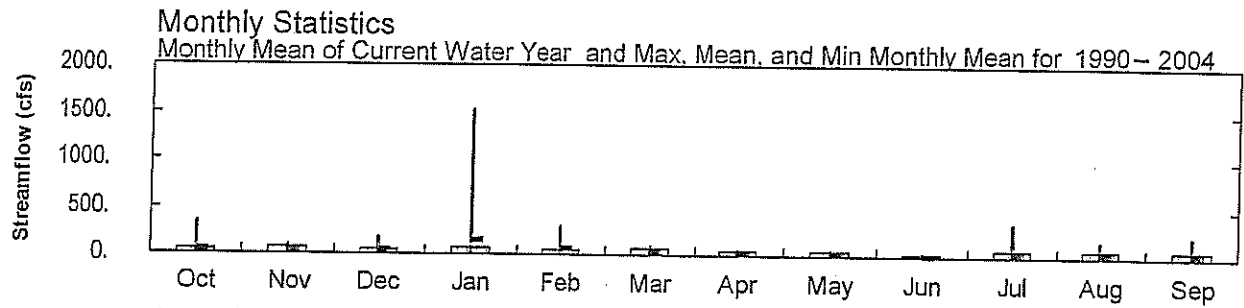
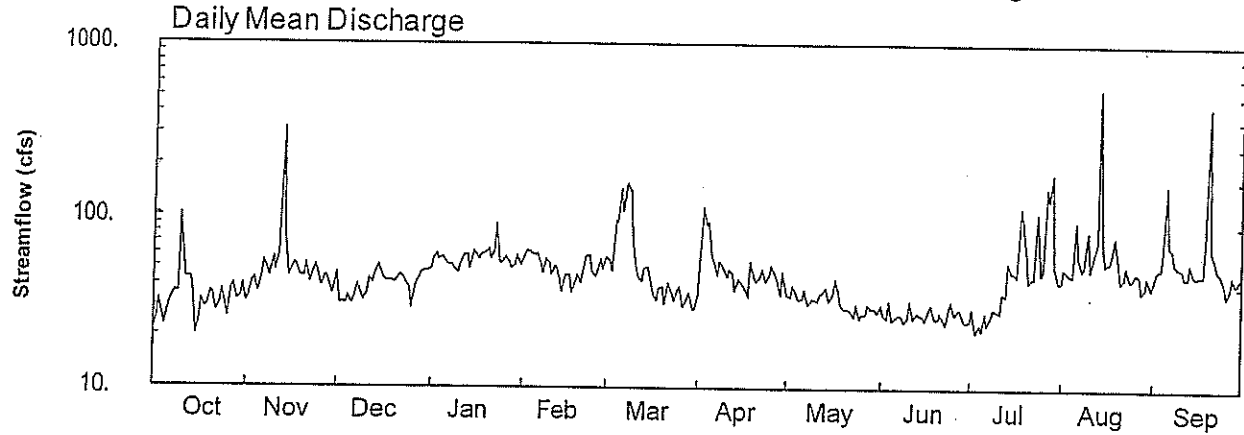
Longitude: 111° 18 ' 25"

Hydrologic Unit Code: 15050303

Pima County

Datum: 1910. feet

Drainage Area: 3641. mi<sup>2</sup>





# Statistical Summaries of Streamflow Data and Characteristics of Drainage Basins for Selected Streamflow-Gaging Stations in Arizona Through Water Year 1996

Water-Resources Investigations Report 98—4225

Prepared in cooperation with the  
Arizona Department of Water Resources,  
Bureau of Reclamation,  
Pima County Board of Supervisors,  
Flood Control District of Maricopa County, and  
Salt River Project

Discharge ratings are updated periodically for active streamflow-gaging stations after a significant change in the stage-discharge relation has occurred. Because of the nature of the controls, the stability and duration of these ratings vary significantly from station to station. Generally the stage-discharge relation is less stable at the lower stages than it is at the higher stages. Sensitivity and unstable conditions at lower flows may require that discharge ratings be revised more frequently to account for these control changes. The rating tables in this report have taken this component into account and have been limited to the upper portions of the rating table that are more stable. Over time, many of the discharge rating tables for the streamflow-gaging stations will be superseded, and users of these data should contact the local office of the USGS to confirm the validity of the ratings.

## EXPLANATION OF STATISTICAL SUMMARIES

Statistical summaries and associated plots for the 320 streamflow-gaging stations include statistics for mean monthly and annual discharge; magnitude and probability of annual high and low flows; magnitude and probability of instantaneous peak flows; and daily mean-flow duration and basin and climatic characteristics. Graphs and box plots represent annual peak discharge, annual mean discharge, and mean monthly and mean annual discharges respectively. Each station description and table heading identifies the period of record for which the statistical summaries are based. For continuous-record streamflow-gaging stations, the statistical summaries of streamflow are calculated from the daily mean values, and flood-frequency calculations are based on the instantaneous peak flows. Summaries for peak-flow partial-record stations only include the flood-frequency and recurrence-interval statistics.

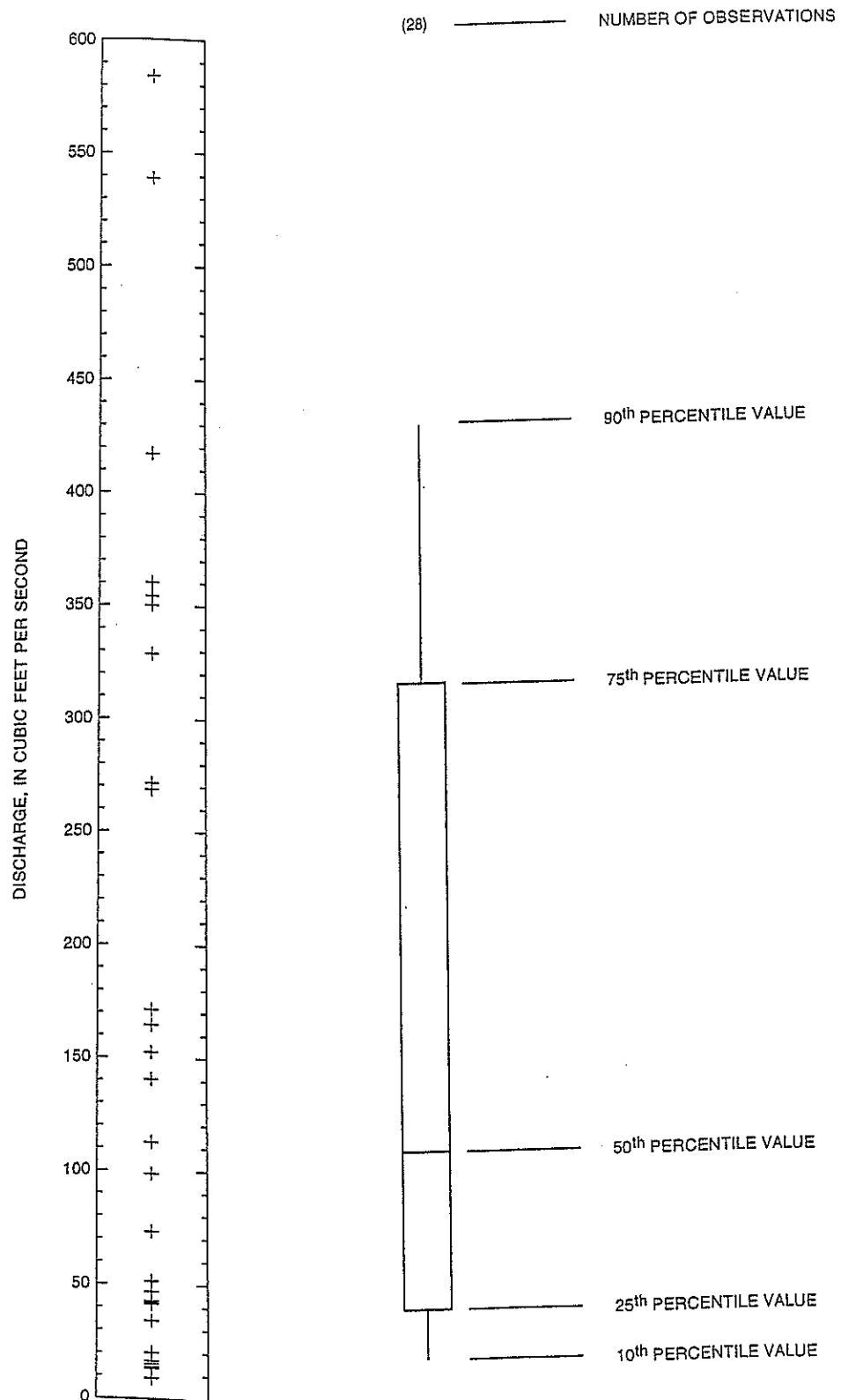
**Monthly and annual flow.**—Mean monthly and annual discharge statistics include the minimum and maximum discharges, mean monthly and annual discharge, the standard deviation of the mean, coefficient of variation, and the percentage of average annual runoff for each month. The minimum and maximum mean monthly discharges are the minimum and maximum flow values of all the mean monthly values for that particular month. The coefficient of variation represents the ratio of the standard deviation to the mean. The percentage of the annual discharge runoff is the percent of the total annual runoff that occurred during each month. Except for low-flow magnitude and probability statistics, annual flows are calculated on the basis of data obtained during a water year.

Boxplots graphically summarize the characteristics of mean monthly and annual discharges and can be used to easily compare data sets. Boxplots were constructed for continuous-record stations and display (1) the median or center of the data, (2) variation of the data, and (3) skewness of the data (fig. 6). The boxplot in figure 6 summarizes the March mean discharges for the period of record at the streamflow-gaging station Blue River near Clifton (table 1). The column of data next to the boxplot in figure 6 is included to show how the data are distributed graphically.

Boxplots are constructed by computing the 10th, 25th, 50th, 75th, and 90th percentiles of the data. The percentile value represents the discharge which exceeds no more than the specified percent of the data. For example, the 10th percentile value is that discharge which exceeds no more than 10 percent of the data.

The bottom and top of the box are defined by the 25th and 75 percentile values, respectively. The vertical lines, called whiskers (Tukey, 1977), extend from the ends of the box to the 10th and 90th percentile values. The 50th percentile value, referred to as the median, defines the line drawn within the box. In the example, the 10th, 25th, 50th, 75th, and 90th percentile values are 13.9, 35.9, 105.6, 314.3, and 429.3 cubic feet per second, respectively.

**Flow magnitude and probability.**—Computations for flow magnitudes and probability statistics are based on the log-Pearson Type III frequency distribution and provide the necessary data to plot standard flow-frequency curves. Magnitude and probability tables for annual low flow list the maximum and minimum average discharge for periods of 1, 3, 7, 14, 30, 60, 90, 120, and 183 consecutive days that correspond to selected recurrence intervals of 2, 5, 10, 20, 50, and 100 years associated with annual nonexceedence probabilities of 50, 20, 10, 5, 2, and 1 percent. Recurrence intervals represent the average



**Figure 6.** Explanation of boxplots. The values described by the boxplot in this explanation are the March mean discharges for the period of record at streamflow gaging station 09442000, Blue River near Clifton.

length of time between annual minimum mean flows that are less than the stated magnitude of flow. Nonexceedence probability, expressed as a percentage, is the probability that the annual maximum and minimum mean flow will be less in any given year than the stated magnitude. Annual low-flow probabilities are computed on discharge values obtained during the climatic year.

Magnitude and probability tables for annual high flow list the maximum average discharge for periods of 1, 3, 7, 15, 30, 60, and 90 consecutive days that correspond to selective recurrence intervals of 2, 5, 10, 25, 50, and 100 years associated with annual exceedance probabilities of 50, 20, 10, 4, 2, and 1 percent. Recurrence intervals represent the average length of time between annual maximum mean flows that are equal to or greater than the stated magnitude of flow. Exceedance probability, expressed as a percentage, is the probability that the annual maximum mean flow will be equal or greater in any given year than the stated magnitude. Annual high-flow probabilities are computed on discharge values obtained during the water year.

**Flood frequency.**—Flood-frequency relations and tabulations provide the necessary data to plot standard flood-frequency curves that are based on log-Pearson Type III frequency distribution, as recommended in the Water Resources Council Guidelines for determining floodflow frequency (Interagency Advisory Committee on Water Data, 1982). These data were calculated for streamflow-gaging stations on unregulated or partly regulated streams. Partly regulated streams are those in which flow is regulated or diverted to an unknown degree.

**Flow duration.**—Flow duration of daily mean discharge, expressed in percentage of time, are specified daily flows that were equaled or exceeded during the period of record. The tabulations show the discharges that were equaled or exceeded for a given percentage of time in 1, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 95, 98, 99, 99.5, and 99.9 percentiles. These data can be used to plot a standard flow-duration curve.

**Discharge.**—Annual peak discharge, mean monthly discharge and mean annual discharge are shown for all continuous-recording gaging stations. Annual peak discharges are included for peak-flow partial-record gaging stations.

**Significant figures and rounding limits.**—The number of significant figures used for reporting discharge in this report is based on the magnitude of the value and is not based on the accuracy of the data. Rounding criteria are used for reporting monthly and annual mean discharge, flow-duration, and probability values for individual streamflow-gaging stations (table 2).

**Table 2.** Significant figures and rounding limits used for reporting monthly and annual mean discharge and probable discharge

[<, less than; ≥, equal to or greater than]

Range in discharge, in cubic feet per second	Significant figures	Rounding limits	Range in discharge, in cubic feet per second	Significant figures	Rounding limits
Monthly and annual mean discharge			Probable discharge		
<0.010	1	Thousandths	<0.10	1	Hundredths
0.010-0.099	2	Thousandths	0.10-0.99	2	Hundredths
0.10-0.99	2	Hundredths	1.0-9.9	2	Tenths
1.00-9.99	3	Hundredths	10-99	2	Units
10.0-99.9	3	Tenths	≥100	3	Variable
100-999	3	Units			
≥1,000	4	Variable			

## GILA RIVER BASIN

413

09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ

CATION.--Lat 31°52'17", long 110°58'46", in SE<sup>1</sup>/<sub>4</sub>SE<sup>1</sup>/<sub>4</sub> sec.11, T.18 S., R.13 E. (unsurveyed), Pima County, Hydrologic Unit 15050301, in Spanish land grant of San Ignacio de la Canoa, on right bank 0.8 mi northeast of Green Valley Post Office, and 1.5 mi north of Continental. Prior to Feb. 13, 1981, at site 1.5 mi upstream.

AINAGE AREA.--1,682 mi<sup>2</sup>, revised, of which 395 mi<sup>2</sup> is in Mexico.

RIOD OF RECORD.--May 1940 to December 1946, October 1951 to September 1985, October 1991 to current year (monthly discharge only for 1985-86), (crest-stage partial record station for 1987-1990). Low-flow records not equivalent prior to Feb. 13, 1981, due to undetermined amount of underflow between sites.

WISED RECORDS.--WSP 1283: Drainage area.

GE.--Water-stage recorder and crest-stage gages. Datum of gage is 2,806.61 ft above sea level. Prior to Feb. 13, 1981, at site 1.5 mi upstream. July 21, 1940 to Sept. 8, 1965 at datum 17.28 ft higher; Sept. 8, 1965 to present at datum 13.21 ft higher. Old site used as supplementary gage until Oct. 29, 1985. --

MARKS.--Records poor. Irrigation above station of about 12,500 acres including about 2,300 acres in Mexico, mostly by pumping from ground water.

VERAGE DISCHARGE.--46 years, 27.1 ft<sup>3</sup>/s, 19,630 acre-ft/yr; median of yearly mean discharges, 9.5 ft<sup>3</sup>/s, 6,900 acre-ft/yr.

TREMES FOR PERIOD OF RECORD.--Maximum discharge, 45,000 ft<sup>3</sup>/s Oct. 2, 1983, gage height, 16.34 ft from rating curve extended above 530 ft<sup>3</sup>/s on basis of float-area measurement at gage height 7.75 ft and slope-area measurement of peak flow, maximum gage height 16.70 ft Oct. 9, 1977, site and datum then in use; no flow for most of each year.

## Annual peak discharges

Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes	Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes
1940	08-14-40	12,100		1971	08-20-71	3,270	
1941	08-09-41	3,670		1972	07-14-72	3,290	
1942	07-28-42	2,700		1973	03-14-73	2,130	
1943	08-01-43	4,000		1974	09-03-74	3,450	
1944	08-12-44	4,440		1975	09-01-75	3,350	
1945	08-09-45	7,820		1976	07-12-76	3,800	
1946	09-09-46	4,120		1977	07-18-77	3,290	
1947	10-01-46	5,330		1978	10-09-77	26,500	
1952	08-15-52	1,820		1979	12-18-78	16,000	
1953	07-14-53	4,910		1980	08-25-80	2,360	
1954	08-05-54	14,600		1981	09-05-81	3,350	
1955	08-19-55	17,500		1982	08-15-82	2,160	
1956	07-29-56	3,090		1983	02-04-83	4,800	
1957	08-21-57	1,690		1984	10-02-83	145,000	
1958	08-05-58	5,620		1985	12-28-84	11,600	
1959	08-17-59	3,900		1986	07-16-86	840	
1960	01-12-60	3,740		1987	08-05-87	340	
1961	08-23-61	4,820		1988	07-28-88	930	
1962	01-25-62	2,480		1989	09-03-89	1,200	
1963	08-06-63	4,220		1990	10-05-89	1,790	
1964	09-10-64	14,000		1991	09-01-91	1,270	
1965	09-12-65	370		1992	08-24-92	4,120	
1966	12-23-65	5,990		1993	01-19-93	32,400	
1967	07-27-67	3,730		1994	08-22-94	707	
1968	12-20-67	18,000		1995	01-06-95	2,350	
1969	08-05-69	1,680		1996	09-03-96	1,520	
1970	07-20-70	3,720					

<sup>1</sup>Highest since 1892.



## GILA RIVER BASIN

09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ--Continued

Discharge rating table developed January 1993

Gage height (ft)	Discharge (ft <sup>3</sup> /s)	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
2.5	57	9.0	7,130
3.0	147	10.0	9,910
4.0	460	11.0	13,300
5.0	1,030	12.0	17,360
6.0	1,920	13.0	22,140
7.0	3,190	14.0	27,700
8.0	4,910	14.7	32,070

## Basin characteristics

Main channel slope (ft/mi)	Stream length (mi)	Mean basin elevation (ft)	Forested area (percent)	Soil index	Mean annual precipitation (in)	Rainfall intensity, 24-hour	
						2-year (in)	50-year (in)
21.0	99.2	4,350	22.0	2.0	18.1	2.1	4.3

## GILA RIVER BASIN

415

## 09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ--Continued

MEAN MONTHLY AND ANNUAL DISCHARGES 1941-46, 1952-85, 1992-96

MONTH	MAXIMUM (FT <sup>3</sup> /S)	MINIMUM (FT <sup>3</sup> /S)	MEAN (FT <sup>3</sup> /S)	STAN- DARD DEVI- ATION (FT <sup>3</sup> /S)	COEFFI- CIENT OF VARI- ATION	PERCENT OF ANNUAL RUNOFF
OCTOBER	1,530	0.00	53	251	4.8	16.1
NOVEMBER	133	0.00	3.3	20	6.1	1.0
DECEMBER	658	0.00	47	146	3.1	14.3
JANUARY	1,390	0.00	56	223	4.0	17.1
FEBRUARY	207	0.00	18	48	2.7	5.4
MARCH	181	0.00	12	37	3.2	3.6
APRIL	32	0.00	0.72	4.7	6.5	0.2
MAY	1.3	0.00	0.03	0.20	6.3	0.0
JUNE	6.2	0.00	0.34	1.2	3.4	0.1
JULY	227	0.00	32	45	1.4	9.9
AUGUST	753	0.00	86	160	1.8	26.3
SEPTEMBER	285	0.00	20	45	2.3	6.1
ANNUAL	206	0.26	28	41	1.5	100

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW  
BASED ON PERIOD OF RECORD 1942-46, 1953-85, 1993-96

PERIOD (CON- SEC- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10# 10%	20# 5%	50# 2%	100# 1%
1						
3						
7						
14						
30						
60						
90	0.00	0.00	0.00	0.00	0.00	0.00
120	0.00	0.00	0.00	0.00	0.00	0.00
183	0.16	0.00	0.00	0.00	0.00	0.00

MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW  
BASED ON PERIOD OF RECORD 1940-47, 1952-96

DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
2 50%	5 20%	10 10%	25 4%	50 2%	100 1%
3,580	7,980	12,800	22,000	32,000	45,400
WEIGHTED SKEW (LOGS)= 0.59					
MEAN (LOGS)= 3.59					
STANDARD DEV. (LOGS)= 0.39					

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW  
BASED ON PERIOD OF RECORD 1941-46, 1952-85, 1992-96

PERIOD (CON- SEC- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10# 10%	25# 4%	50# 2%	100# 1%
1	1,000	3,260	6,180	12,400	19,700	30,000
3	518	1,750	3,390	6,920	11,100	17,000
7	270	920	1,780	3,640	5,830	8,950
15	159	533	1,010	2,010	3,150	4,730
30	105	332	598	1,110	1,640	2,320
60	63	196	348	634	928	1,300
90	44	136	241	439	643	902

DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1941-46, 1952-85, 1992-96

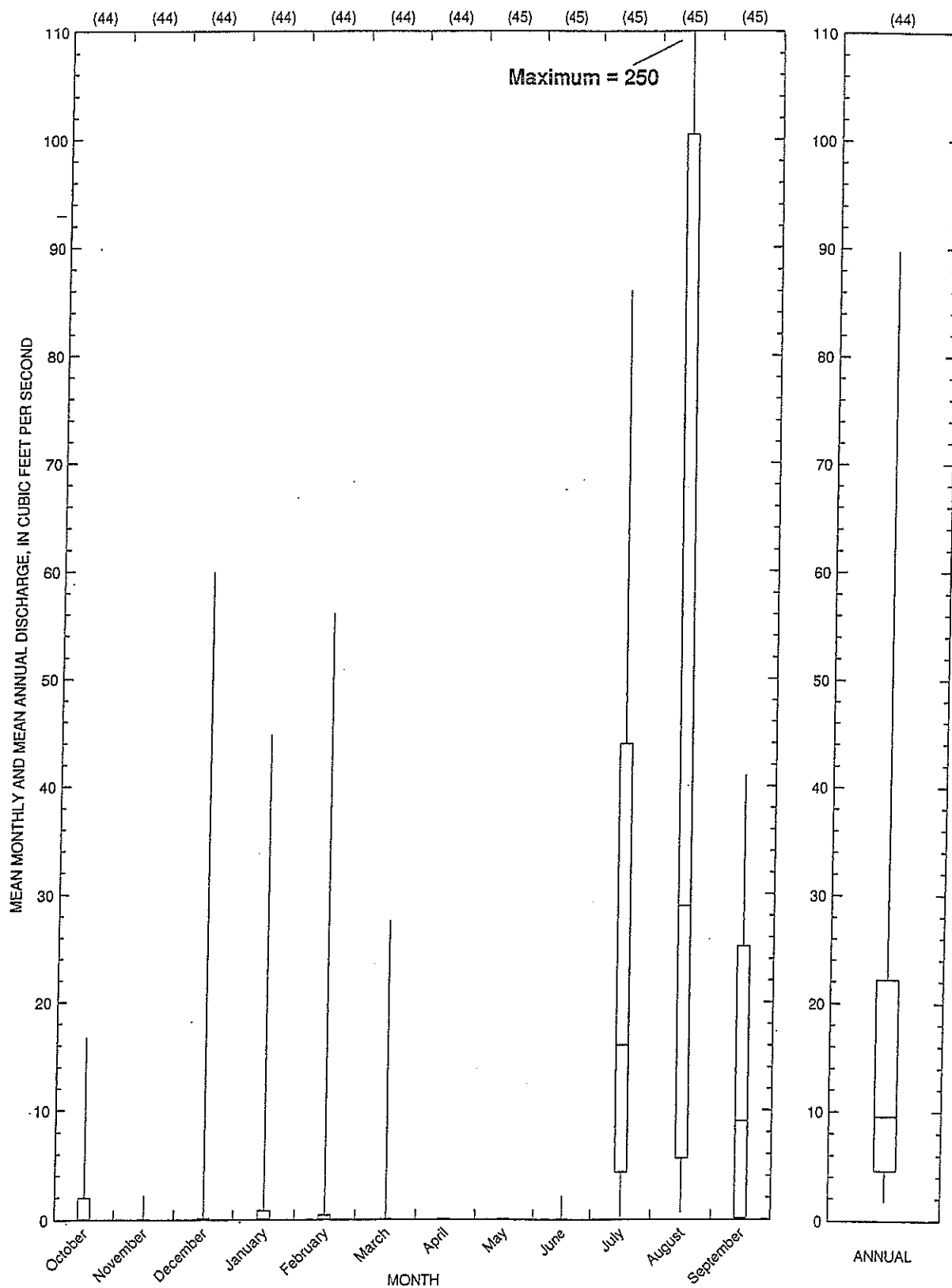
DISCHARGE, IN FT <sup>3</sup> /S, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME															
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%
600	52	2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

# Reliability of values in column is uncertain, and potential errors are large.

# GILA RIVER BASIN

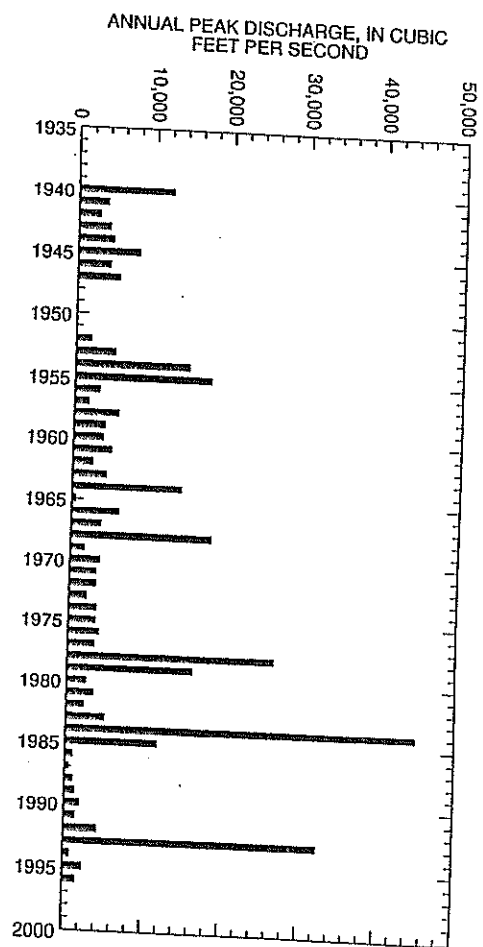
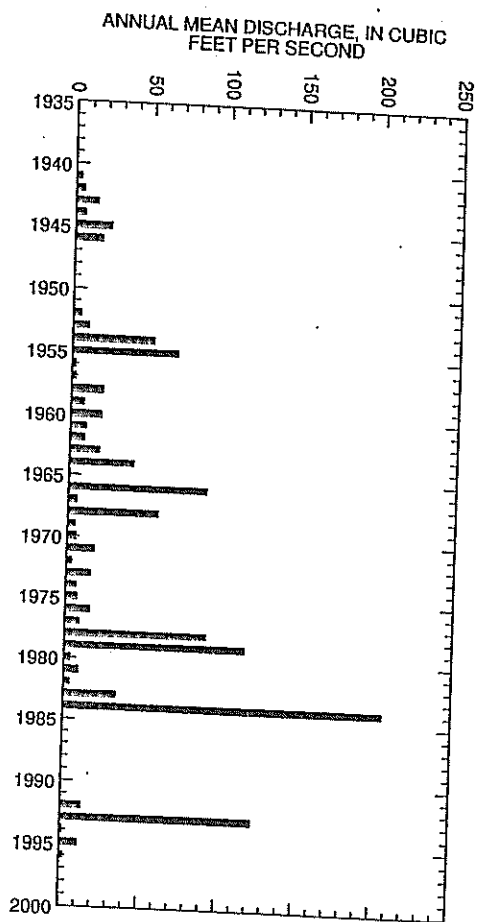
417

09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ--Continued



## GILA RIVER BASIN

09482000 SANTA CRUZ RIVER AT CONTINENTAL, AZ--Continued



## GILA RIVER BASIN

09482500 SANTA CRUZ RIVER AT TUCSON, AZ

LOCATION.--Lat 32°13'19", long 110°58'52", in SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec.11, T.14 S., R.13 E., Pima County, Hydrologic Unit 15050301, on right bank, 2 ft downstream from Congress Street Bridge, in Tucson.

DRAINAGE AREA.--2,222 mi<sup>2</sup>, of which 395 mi<sup>2</sup> is in Mexico, adjusted for 15.2 mi<sup>2</sup> of Tucson Arroyo drainage area contributing to this station effective July 1956.

PERIOD OF RECORD.--October 1905 to September 1981 (monthly discharge only, January 1907 to September 1912, January to September 1914), June 1986 to September 1995 (discharge above 500 ft<sup>3</sup>/s only), October 1995 to September 1996.

REVISED RECORDS.--WSP 859: 1915(M). WSP 1283: Drainage area. WSP 1313: 1939(M). WDR AZ-88-1: 1986-87(M).

GAGE.--Water-stage recorder and crest-stage gage. Datum of gage is 2,320.68 ft above sea level. Prior to Nov. 27, 1929, nonrecording gages reference points for measuring to water surface at various places on Congress Street bridge at various datums. Nov. 27, 1929 to Sept. 3, 1981, water-stage recorder at Congress Street bridge: at datum 6.22 ft higher Nov. 27, 1929 to June 18, 1958; at datum 2.22 ft higher June 18, 1958 to May 21, 1963; at datum 3.48 ft lower May 21, 1963 to Oct. 27, 1970; at datum 2.86 ft lower Oct. 1, 1971 to Sept. 30, 1981. N gage Oct. 27, 1970 to Oct. 1, 1971, and Oct. 10, 1977, to Feb. 14, 1978.

REMARKS.--Records fair. Irrigation above station of about 26,000 acres, including about 2,300 acres in Mexico, mostly by pumping from groundwater. Ground water is also pumped above the station for municipal supply and mining. From October 1969 to September 1981, all flow past station was published, including waste water when known.

AVERAGE DISCHARGE.--77 years (water years 1906-81, 1996), 22.5 ft<sup>3</sup>/s, 16,300 acre-ft/yr; median of yearly mean discharges, 13 ft<sup>3</sup>/s, 9,400 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 37,400 ft<sup>3</sup>/s Jan. 19, 1993, gage height, 11.67 ft; no flow for most of each year.

EXTREMES OUTSIDE PERIOD OF RECORD.--Maximum discharge since at least 1892, 52,700 ft<sup>3</sup>/s, from slope-area measurement of peak flow, Oct. 2, 1983; gage height, 22.2 ft, from floodmark, at site and datum used in 1981.

Maximum discharge during the 1985 water year was 10,000 ft<sup>3</sup>/s Dec. 28, 1984; gage height, 12.5 ft, at site and datum used in 1981.

## GILA RIVER BASIN

435

09482500 SANTA CRUZ RIVER AT TUCSON, AZ--Continued

## Annual peak discharges

Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes	Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes
1915	12-23-14	<sup>1</sup> 15,000		1956	07-29-56	2,610	
1916	01-20-16	5,000		1957	08-31-57	3,050	
1917	09-08-17	7,500		1958	07-29-58	6,350	
1918	08-07-18	4,900		1959	08-20-59	4,420	
1919	08-02-19	4,700		1960	08-10-60	6,140	
1920	08-09-20	1,950		1961	08-23-61	16,600	
1921	08-01-21	4,000		1962	09-26-62	4,980	
1922	07-20-22	2,000		1963	08-26-63	4,670	
1923	08-17-23	1,900		1964	09-10-64	13,000	
1924	11-17-23	2,050		1965	07-16-65	1,190	
1925	09-18-25	3,400		1966	08-19-66	5,500	
1926	09-28-26	11,400		1967	07-17-67	5,860	
1927	09-07-27	1,950		1968	12-20-67	16,100	
1928	08-01-28	1,600		1969	08-06-69	8,710	
1929	09-24-29	10,400		1970	07-20-70	8,530	
1930	08-07-30	1,770		1971	08-17-71	8,000	
1931	08-10-31	9,200		1972	07-15-72	3,470	
1932	07-30-32	4,200		1973	10-19-72	4,710	
1933	08-21-33	6,100		1974	07-08-74	7,930	
1934	08-23-34	6,000		1975	07-12-75	2,480	
1935	09-01-35	10,300		1976	09-25-76	7,100	
1936	07-26-36	5,400		1977	08-15-77	2,660	
1937	07-10-37	3,280		1978	10-10-77	23,700	
1938	08-05-38	9,000		1979	12-19-78	13,500	
1939	08-03-39	8,000		1980	08-13-80	2,760	
1940	08-14-40	11,300		1981	07-27-81	2,700	
1941	08-14-41	2,490		1982	00-00-82	10,000	
1942	08-09-42	1,670		1983	00-00-83	7,000	
1943	08-02-43	4,510		1984	10-02-83	<sup>2</sup> 52,700	
1944	08-16-44	6,530		1985	12-28-84	10,000	
1945	08-10-45	10,800		1986	07-21-86	1,920	HP
1946	08-04-46	4,260		1987	08-02-87	1,500	
1947	10-01-46	2,960		1988	08-23-88	10,700	
1948	08-16-48	3,860		1989	10-20-88	2,960	
1949	08-08-49	3,800		1990	07-24-90	9,430	
1950	07-30-50	9,490		1991	08-09-91	2,130	
1951	08-02-51	5,020		1992	08-06-92	5,970	
1952	08-16-52	3,820		1993	01-19-93	37,400	
1953	07-15-53	5,900		1994	07-28-94	4,890	
1954	07-24-54	9,570		1995	02-16-95	576	
1955	08-03-55	10,900		1996	09-03-97	9,370	

<sup>1</sup>Highest since 1905.<sup>2</sup>Highest since 1892.

## GILA RIVER BASIN

09482500 SANTA CRUZ RIVER AT TUCSON, AZ--Continued

Discharge rating table developed October 1992

Gage height (ft)	Discharge (ft <sup>3</sup> /s)	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
2.0	73	7.0	9,600
2.5	263	8.0	14,000
3.0	570	9.0	19,400
4.0	1,700	10.0	25,000
5.0	3,550	11.0	32,500
6.0	6,100	12.0	40,000

## Basin characteristics

Main channel slope (ft/mi)	Stream length (mi)	Mean basin elevation (ft)	Forested area (percent)	Soil index	Mean annual precipitation (in)	Rainfall intensity, 24-hour	
						2-year (in)	50-year (in)
20.1	128	4,050	17.0	2.0	16.9	2.1	4.2

## GILA RIVER BASIN

437

## 09482500 SANTA CRUZ RIVER AT TUCSON, AZ--Continued

MEAN MONTHLY AND ANNUAL DISCHARGES 1906, 1913, 1915-81, 1996

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW  
BASED ON PERIOD OF RECORD 1916-81

MONTH	MAXIMUM (FT <sup>3</sup> /S)	MINIMUM (FT <sup>3</sup> /S)	MEAN (FT <sup>3</sup> /S)	STAN- DARD DEVI- ATION (FT <sup>3</sup> /S)	COEFFI- CIENT OF VARI- ATION	PERCENT OF ANNUAL RUNOFF	PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
								2 50%	5 20%	10# 10%	20# 5%	50# 2%	100# 1%
OCTOBER	656	0.00	13	79	6.0	4.9							
NOVEMBER	215	0.00	6.5	28	4.3	2.4							
DECEMBER	895	0.00	35	145	4.1	13.0	1						
JANUARY	518	0.00	21	81	3.8	7.8	3						
FEBRUARY	202	0.00	11	37	3.3	4.1	7						
MARCH	102	0.00	4.8	17	3.6	1.8	14						
APRIL	1.7	0.00	0.10	0.28	2.7	0.0	30						
MAY	2.3	0.00	0.09	0.34	3.8	0.0	60	0.00	0.00	0.00	0.00	0.00	0.00
JUNE	25	0.00	1.4	4.3	3.2	0.5	90	0.00	0.00	0.00	0.00	0.00	0.00
JULY	430	0.00	51	71	1.4	18.8	120	0.12	0.00	0.00	0.00	0.00	0.00
AUGUST	682	0.00	93	114	1.2	34.4	183	0.76	0.08	0.00	0.00	0.00	0.00
SEPTEMBER	312	0.00	33	60	1.8	12.3							
ANNUAL	112	1.3	23	23	1.0	100							

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW  
BASED ON PERIOD OF RECORD 1906, 1913, 1915-81, 1996MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW  
BASED ON PERIOD OF RECORD 1915-81, 1984-96

DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT						PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
2 50%	5 20%	10 10%	25 4%	50 2%	100 1%		2 50%	5 20%	10# 10%	25# 4%	50# 2%	100# 1%
5,110	9,720	13,800	20,300	26,300	33,300	1	1,410	3,230	4,840	7,330	9,480	11,900
						3	703	1,640	2,480	3,770	4,890	6,130
						7	364	852	1,300	2,000	2,610	3,310
						15	211	484	730	1,110	1,450	1,820
						30	131	291	434	654	845	1,060
						60	79	174	262	403	533	684
						90	56	122	183	282	371	475
WEIGHTED SKEW (LOGS)= 0.22												
MEAN (LOGS)= 3.72												
STANDARD DEV. (LOGS)= 0.32												

DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1906, 1913, 1915-81, 1996

DISCHARGE, IN FT <sup>3</sup> /S, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME																
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%	99.9%
535	50	5.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

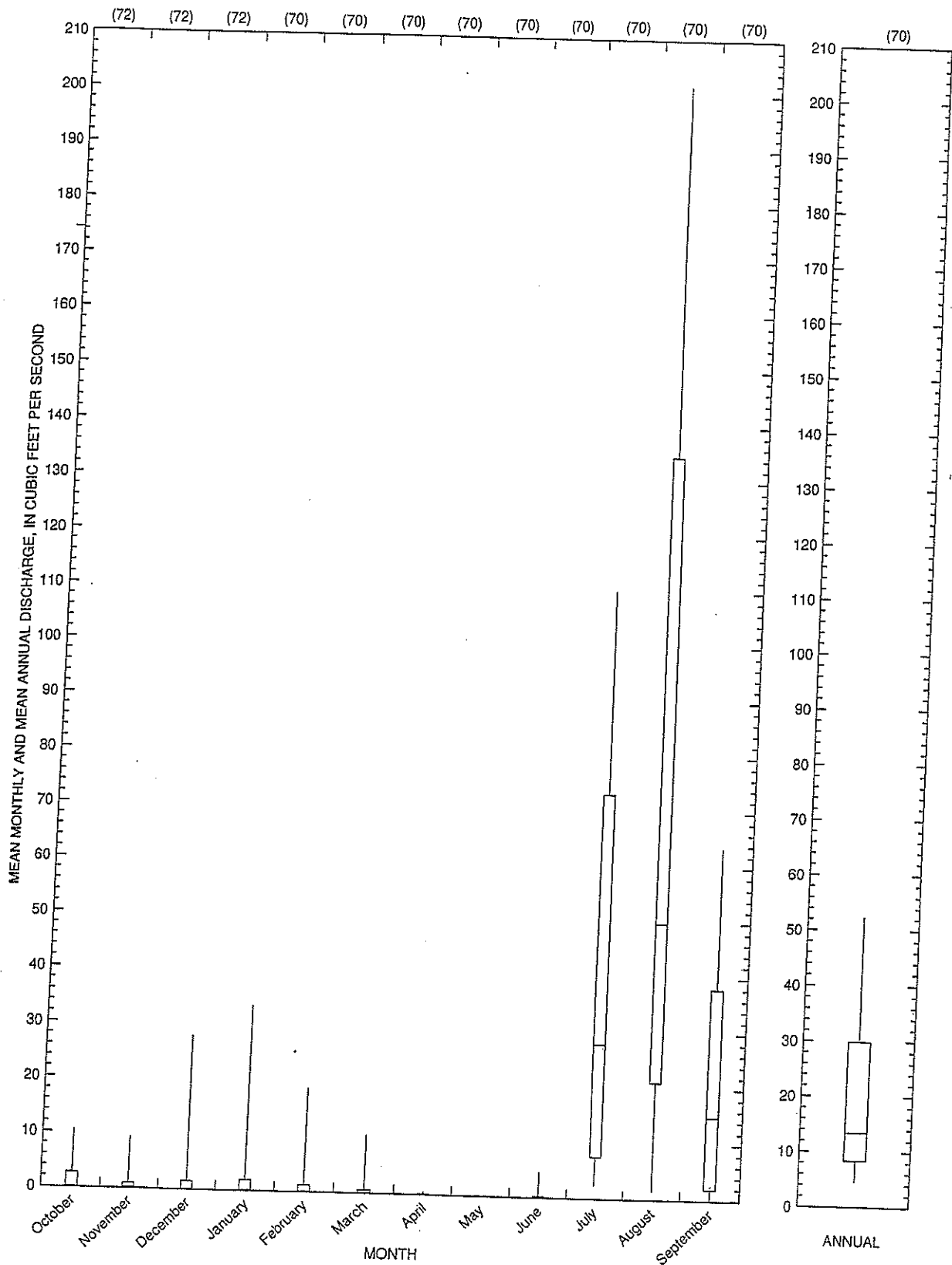
# Reliability of values in column is uncertain, and potential errors are large.



# GILA RIVER BASIN

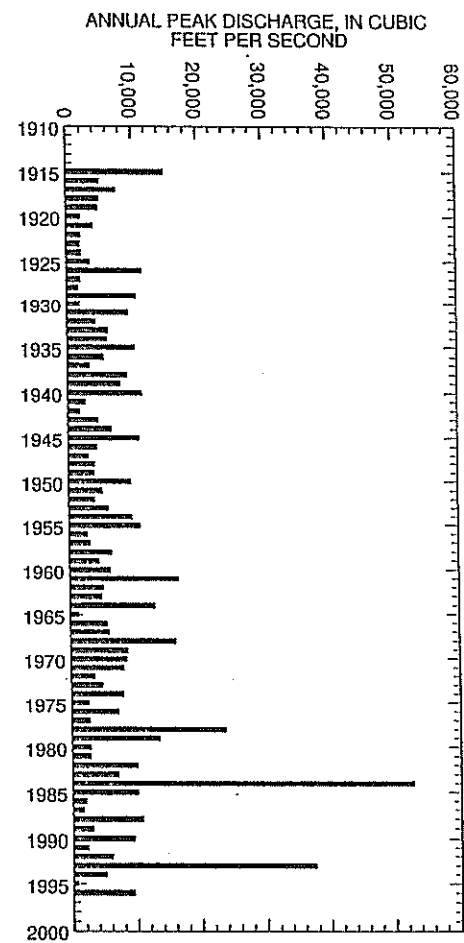
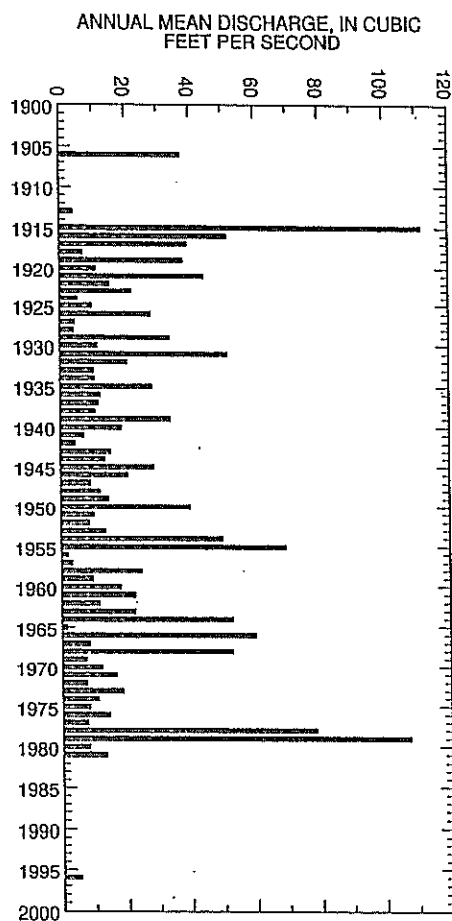
439

09482500 SANTA CRUZ RIVER AT TUCSON, AZ--Continued



## GILA RIVER BASIN

09482500 SANTA CRUZ RIVER AT TUCSON, AZ--Continued



## 09486500 SANTA CRUZ RIVER AT CORTARO, AZ

LOCATION.--Lat 32°21'04", long 111°05'38", in NW<sup>1</sup>/<sub>4</sub>NW<sup>1</sup>/<sub>4</sub>NW<sup>1</sup>/<sub>4</sub> sec.35, T.12 S., R.12 E., Pima County, Hydrologic Unit 15050302, at center column of bridge pier on left bank, 0.5 mi southwest of Cortaro, 1.0 mi downstream from Ina Road treatment plant, 2.6 mi downstream from Canada del Oro, and 3.7 mi downstream from Rillito Creek.

DRAINAGE AREA.--3,503 mi<sup>2</sup>, of which 395 mi<sup>2</sup> is in Mexico.

PERIOD OF RECORD.--October 1939 to June 1947 (published as "at Rillito"), July 1950 to September 1984, March to June 1990, July to September 1990 (fragmentary record), October 1990 to current year.

REVISED RECORDS.--WSP 1283: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,100.00 ft, above sea level. Prior to June 30, 1947, at site 5.5 mi downstream at different datum. July 8, 1950 to Jan. 20, 1966 at present site at datum 19.11 ft lower. Jan. 20, 1966, to Sept. 30, 1984 at present site and datum 23.11 ft lower. Aug. 1 to Oct. 19, 1990, at site on right bank 600 ft downstream from bridge at datum 30.20 ft lower. Apr. 10 to May 17, 1991, at site on bridge, 200 ft toward right bank, at different datum. Supplementary water-stage recorder on downstream site on left bridge pier at datum 19.11 ft lower Aug. 29, 1969 to Sept. 30, 1984. Temporary water-stage recorder on right bank Oct. 27, 1983 to Sept. 30, 1984 at datum 20.80 ft lower.

REMARKS.--Records poor. Many diversions above station, mostly by pumping from ground water, for irrigation of about 34,000 acres. Waste water from irrigation and from sewage-disposal plants is included in flow past station in water years 1951, 1952, 1970-82, 1990-95.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 65,000 ft<sup>3</sup>/s Oct. 2, 1983, gage height 16.57 ft from floodmark, computed by flood-routing method from Santa Cruz River at Tucson and Rillito Creek at Tucson; no natural flow for most of each year. (See REMARKS)

## Annual peak discharge

Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes	Water year	Date	Annual peak discharge (ft <sup>3</sup> /s)	Discharge codes
1940	08-14-40	<sup>1</sup> 17,000		1967	07-17-67	5,740	
1941	12-31-40	7,800		1968	12-21-67	15,800	
1942	08-09-42	1,550		1969	08-06-69	8,400	
1943	09-24-43	5,500		1970	07-20-70	11,200	
1944	08-16-44	5,650		1971	08-20-71	9,100	
1945	08-10-45	14,000		1972	08-12-72	7,050	
1946	08-04-46	4,440		1973	10-19-72	9,000	
1947	08-15-47	7,500		1974	07-08-74	11,700	
1950	07-30-50	12,900		1975	07-12-75	5,200	
1951	07-25-51	6,820		1976	09-25-76	10,600	
1952	08-14-52	6,100		1977	09-10-77	4,700	
1953	07-14-53	10,800		1978	10-10-77	23,000	
1954	07-24-54	9,150		1979	12-18-78	18,800	
1955	08-03-55	16,600		1980	07-19-80	2,650	
1956	07-29-56	3,150		1981	09-22-81	4,310	
1957	09-01-57	4,400		1982	08-23-82	13,300	
1958	08-12-58	7,890		1983	02-04-83	7,620	
1959	08-20-59	8,000		1984	10-02-83	<sup>2</sup> 65,000	HP
1960	08-11-60	6,420		1985	12-28-84	13,000	
1961	08-23-61	14,700		1990	07-24-90	27,500	
1962	09-26-62	11,200		1991	03-01-91	11,600	
1963	08-26-63	7,240		1992	08-24-92	4,670	
1964	09-10-64	15,900		1995	02-15-95	6,170	
1965	07-16-65	2,710		1996	09-03-96	16,400	
1966	12-22-65	16,800					

<sup>1</sup>Highest since 1935.

<sup>2</sup>Highest since 1959.

## GILA RIVER BASIN

09486500 SANTA CRUZ RIVER AT CORTARO, AZ--Continued

Discharge rating table developed October 1993

Gage height (ft)	Discharge (ft <sup>3</sup> /s)	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
6.0	1,700	9.5	9,410
6.5	2,290	10.0	11,400
7.0	3,020	10.5	13,700
7.5	3,900	11.0	16,200
8.0	4,960	11.5	19,200
8.5	6,220	12.0	22,500
9.0	7,690	12.5	26,100

## Basin characteristics

Main channel slope (ft/mi)	Stream length (mi)	Mean basin elevation (ft)	Forested area (percent)	Soil index	Mean annual precipitation (in)	Rainfall intensity, 24-hour	
						2-year (in)	50-year (in)
20.3	140	4,000	18.0	1.8	16.3	2.0	4.2

## GILA RIVER BASIN

519

## 09486500 SANTA CRUZ RIVER AT CORTARO, AZ--Continued

MEAN MONTHLY AND ANNUAL DISCHARGES 1940-46, 1951-82, 1991-96

MONTH	MAXIMUM (FT <sup>3</sup> /S)	MINIMUM (FT <sup>3</sup> /S)	MEAN (FT <sup>3</sup> /S)	STAN- DARD DEVI- ATION (FT <sup>3</sup> /S)	COEFFI- CIENT OF VARI- ATION	PERCENT OF ANNUAL RUNOFF
OCTOBER	744	0.00	40	114	2.8	6.4
NOVEMBER	168	0.00	22	32	1.5	3.5
DECEMBER	1,040	0.00	86	217	2.5	13.5
JANUARY	2,490	0.00	105	383	3.6	16.7
FEBRUARY	252	0.00	43	60	1.4	6.8
MARCH	496	0.00	38	79	2.1	6.1
APRIL	60	0.00	15	20	1.3	2.4
MAY	53	0.00	14	19	1.3	2.2
JUNE	61	0.00	15	18	1.2	2.4
JULY	393	1.7	72	79	1.1	11.4
AUGUST	868	2.0	122	142	1.2	19.4
SEPTEMBER	358	0.00	59	70	1.2	9.3
ANNUAL	262	2.6	53	50	0.95	100

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW  
BASED ON PERIOD OF RECORD 1941-47, 1952-82, 1992-96

PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	20 5%	50# 2%	100# 1%
1	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
90	0.43	0.00	0.00	0.00	0.00	0.00
120	3.8	0.00	0.00	0.00	0.00	0.00
183	11	1.5	0.35	0.07	0.00	0.00

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW  
BASED ON PERIOD OF RECORD 1940-46, 1951-82, 1991-96MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW  
BASED ON PERIOD OF RECORD 1940-47, 1950-85, 1990-96

DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT						
2 50%	5 20%	10 10%	25 4%	50 2%	100 1%	
8,780	15,000	20,400	29,000	36,800	46,000	
WEIGHTED SKEW (LOGS)= 0.46						
MEAN (LOGS)= 3.96						
STANDARD DEV. (LOGS)= 0.26						

PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT <sup>3</sup> /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	25# 4%	50# 2%	100# 1%
1	2,040	5,050	8,080	13,300	18,300	24,400
3	1,020	2,560	4,180	7,090	10,000	13,700
7	541	1,330	2,130	3,530	4,900	6,580
15	314	760	1,210	2,010	2,790	3,750
30	202	464	714	1,130	1,520	1,970
60	132	290	432	652	846	1,060
90	101	218	316	460	579	707

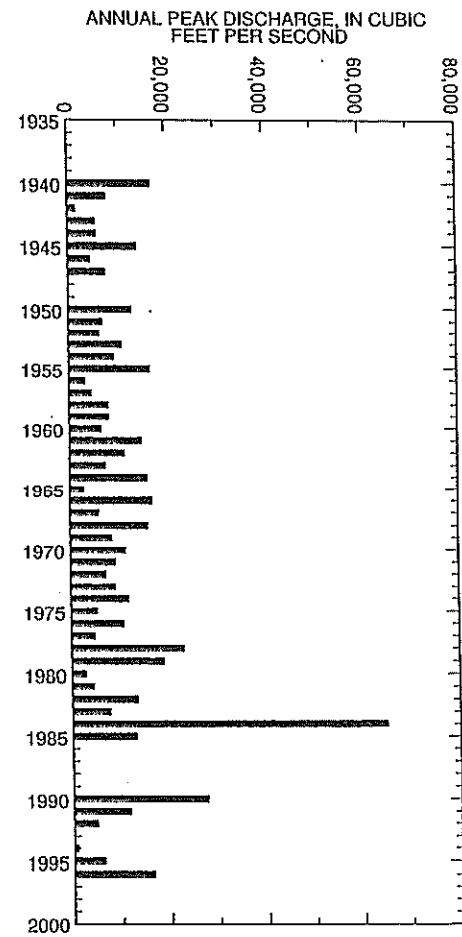
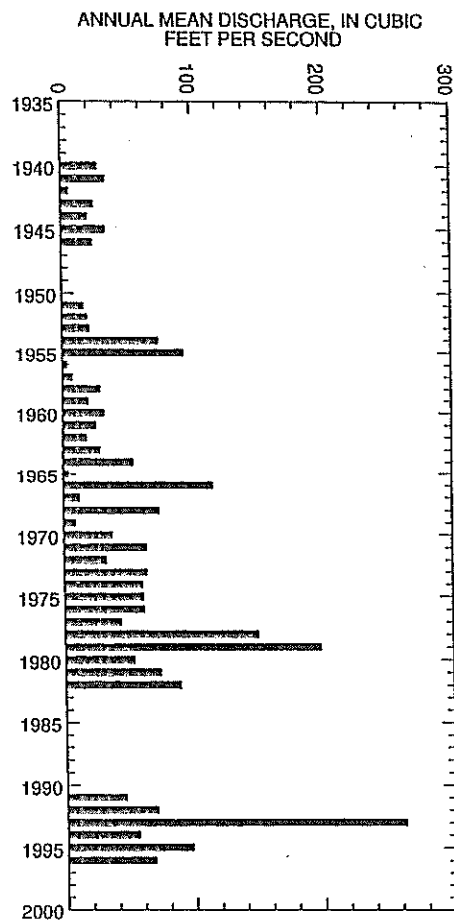
DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1940-46, 1951-82, 1991-96

DISCHARGE, IN FT <sup>3</sup> /S, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME																	
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%	99.9%	
833	105	65	54	47	35	21	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

# Reliability of values in column is uncertain, and potential errors are large.

## GILA RIVER BASIN

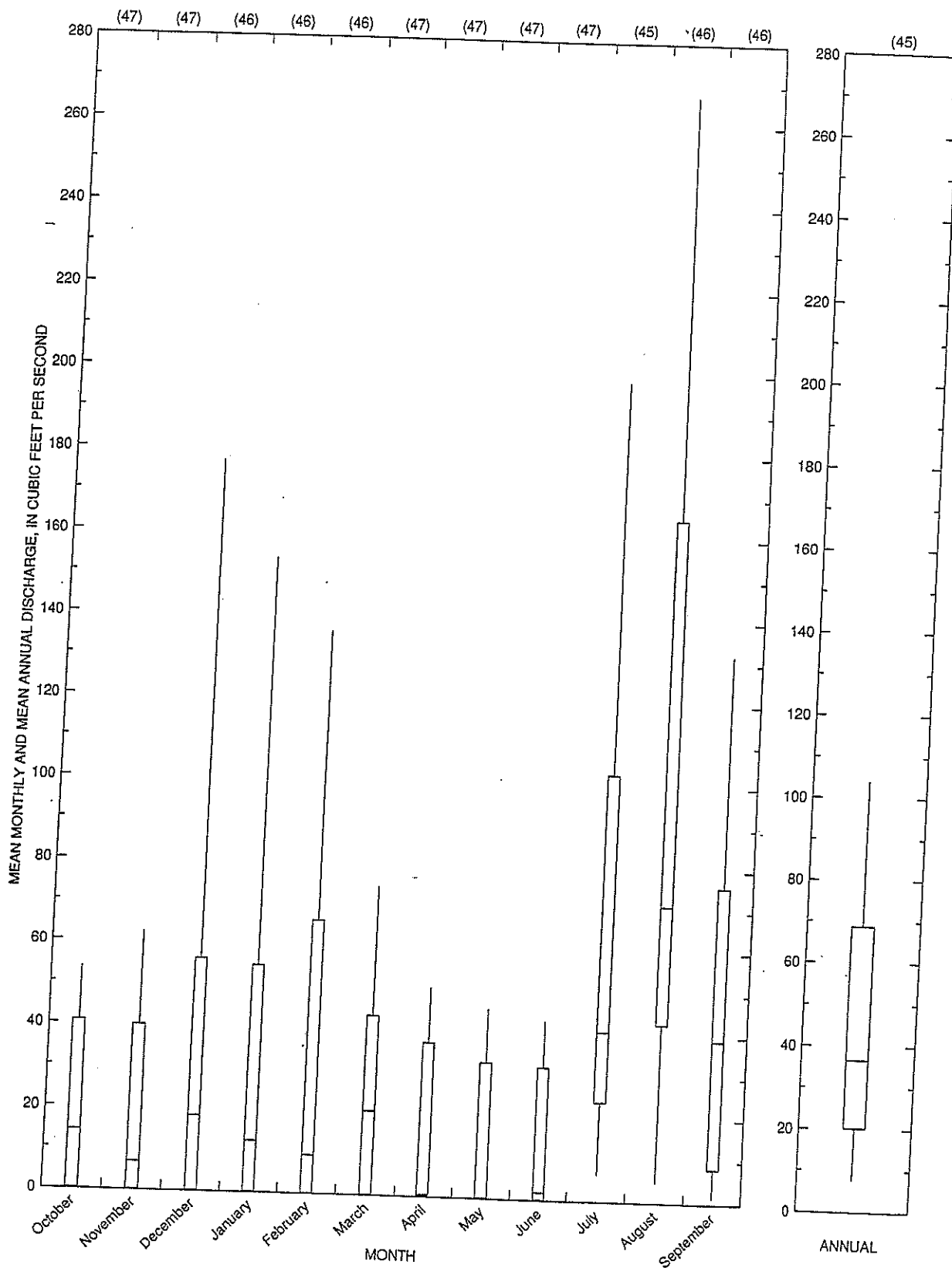
09486500 SANTA CRUZ RIVER AT CORTARO, AZ--Continued



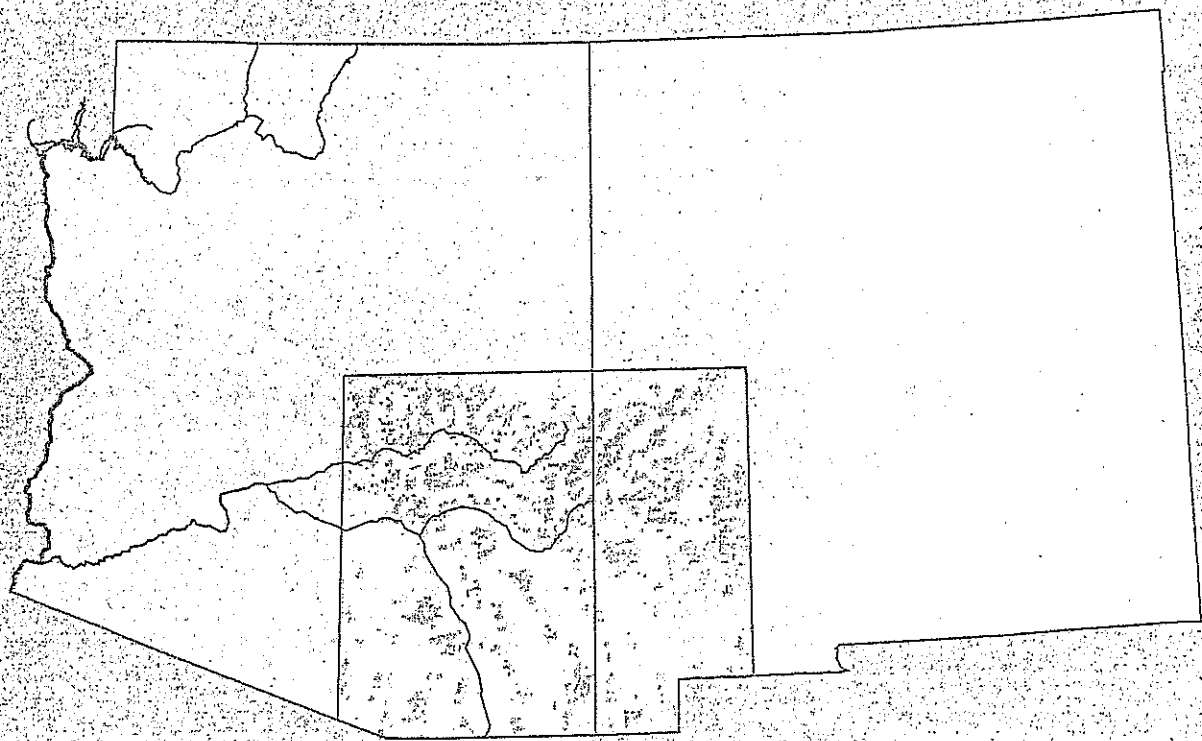
# GILA RIVER BASIN

521

09486500 SANTA CRUZ RIVER AT CORTARO, AZ--Continued



USGS National Water Research Institute  
at the University of Wisconsin - Stevens Point  
Stevens Point, WI 54481  
Stevens Point, WI 54481



Associated with the



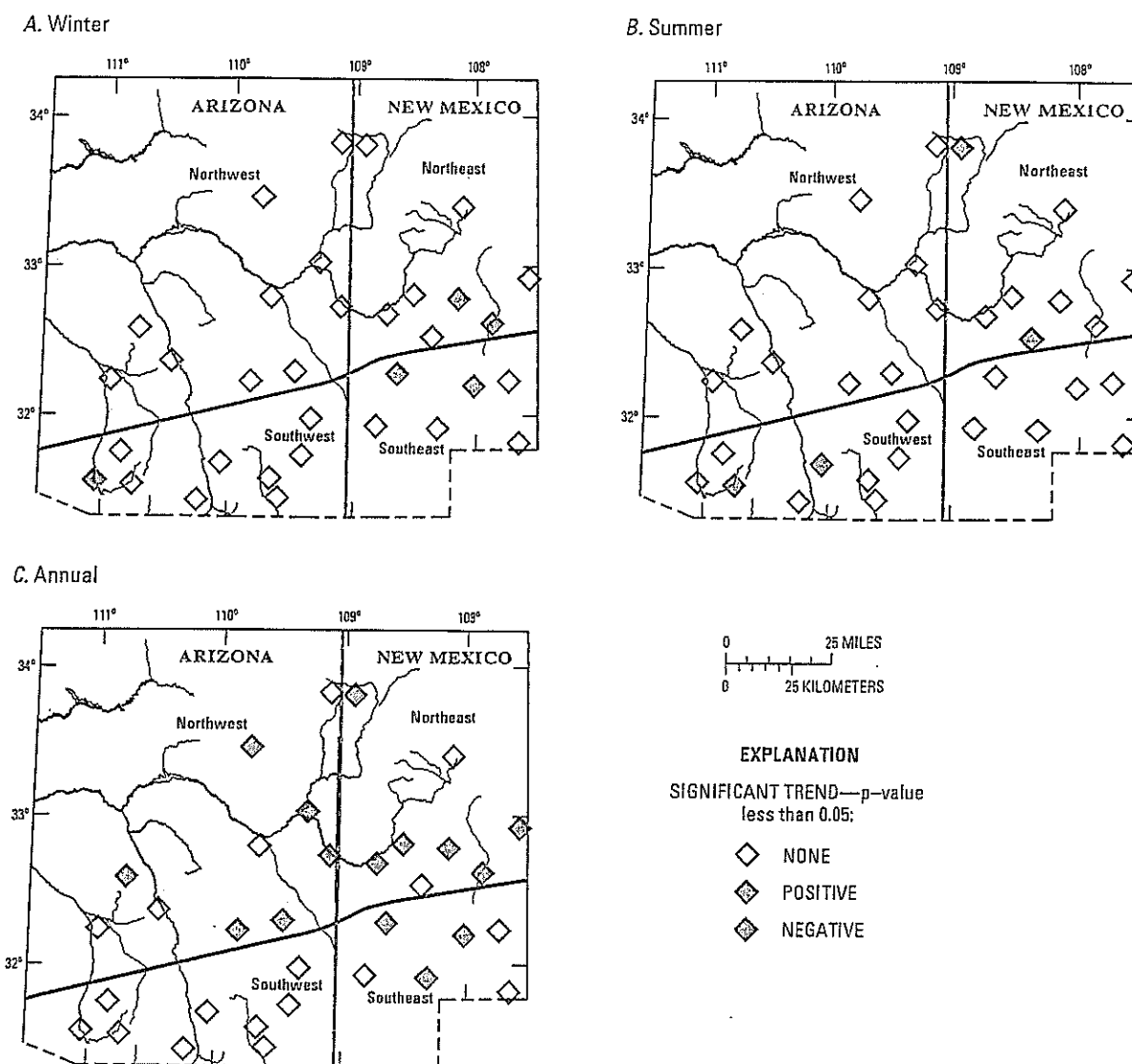


Figure 6. Regional trends in precipitation, 1950–2002. A, Winter; B, Summer; C, Annual.

## Trends in Streamflow

The analysis of regional trends in streamflow was limited by the incomplete records and spatial distribution of streamflow data in the study area. Whereas 21 gaging stations had at least 25 years of data, only 6 stations had complete records that could be used for a rigorous analysis of regional trends during 1930–2002 (table 4). There were 10 gaging stations on 4 rivers (table 2), so 6 of those stations could not be used because of spatial correlation. Another 9 stations were not used because the records had large blocks of time when the stations were discontinued. The streamflow data from the 15 gaging

stations not used for the rigorous regional comparison were still evaluated, but with attention to their limitations (table 5).

Seasonal and annual streamflow had no trends for most of the 11 analyzed time periods; 79 percent of the 330 trend tests performed on individual sites were not significant (table 4). The time periods that did have significant streamflow trends were not as clustered about the mid-century drought as were the significant trends for precipitation. Sixty-six percent of the significant trends were for time periods that started before 1955. Most significant trends in winter, spring, fall, and annual flows were positive, and 95 percent of the significant trends in summer flows were negative.

16 Trends in Streamflow of the San Pedro River and Regional Trends in Precipitation and Streamflow, AZ and NM

**Table 4.** Trends in seasonal and annual total streamflow at 6 gaging stations for 11 time periods, 1930–2002, southeastern Arizona and southwestern New Mexico

[<, less than; nr, near; AZ, Arizona; NM, New Mexico; NA, data are not sufficient for significance testing (< 20 years)]

			Significant trend in flow (p-value < 0.05) <sup>3</sup> (p is positive trend and n is negative trend)											
			Starting year for trend test (data for all tests end in 2002)											
Season <sup>1</sup>	Gaging station name	Part of study area <sup>2</sup>	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	
Winter	San Pedro River at Charleston, AZ	southwest												
	Santa Cruz River nr Nogales, AZ													
	San Carlos River nr Peridot, AZ	northwest											n	
	Sabino Creek nr Tucson, AZ											NA	NA	
	Gila River nr Gila, NM	northeast												
	San Francisco River nr Glenwood, NM				p	p	p	p						
Spring	San Pedro River at Charleston, AZ	southwest	n	n	n						n	n		
	Santa Cruz River nr Nogales, AZ													
	San Carlos River nr Peridot, AZ	northwest	p	p	p	p	p	p	p					
	Sabino Creek nr Tucson, AZ											NA	NA	
	Gila River nr Gila, NM	northeast												
	San Francisco River nr Glenwood, NM						p							
Summer	San Pedro River at Charleston, AZ	southwest	n	n	n	n	n	n	n	n	n			
	Santa Cruz River nr Nogales, AZ		n	n	n	n	n	n		n	n	n		
	San Carlos River nr Peridot, AZ	northwest												
	Sabino Creek nr Tucson, AZ											NA	NA	
	Gila River nr Gila, NM	northeast		p										
	San Francisco River nr Glenwood, NM													
Fall	San Pedro River at Charleston, AZ	southwest	n											
	Santa Cruz River nr Nogales, AZ													
	San Carlos River nr Peridot, AZ	northwest				p	p						n	
	Sabino Creek nr Tucson, AZ											NA	NA	
	Gila River nr Gila, NM	northeast			p	p	p							
	San Francisco River nr Glenwood, NM					p	p							
Annual	San Pedro River at Charleston, AZ	southwest	n	n	n	n	n				n			
	Santa Cruz River nr Nogales, AZ													
	San Carlos River nr Peridot, AZ	northwest				p							n	
	Sabino Creek nr Tucson, AZ		p	p	p	p						NA	NA	
	Gila River nr Gila, NM	northeast	p	p	p	p	p							
	San Francisco River nr Glenwood, NM		p	p	p	p	p							

<sup>1</sup>Winter is November–March, spring is April–June, summer is July–August, and fall is September–October.

<sup>2</sup>See figure 2.

<sup>3</sup>A Kendall tau trend test was made on seasonal and annual average streamflow.

**Table 5.** Trends in seasonal and annual total streamflow at 21 gaging stations for periods of record, southeastern Arizona and southwestern New Mexico

[&lt;, less than; SIp, slope; nr, near; Riv, river; Cr, creek; &gt;, greater than]

Part of study area <sup>1</sup>	Map no. <sup>1</sup>	Gaging-station name	Period of record	Kendall tau trend test <sup>2</sup>									
				Winter <sup>3</sup>		Spring <sup>3</sup>		Summer <sup>3</sup>		Fall <sup>3</sup>		Annual	
				Slp <sup>4</sup>	p-value	Slp <sup>4</sup>	p-value	Slp <sup>4</sup>	p-value	Slp <sup>4</sup>	p-value	Slp <sup>4</sup>	p-value
southwest	2	San Pedro Riv at Palominas	<sup>5</sup> 1931–2002	n	0.032	n	0.041	n	0.024	n	0.295	n	0.049
	3	San Pedro Riv at Charleston	1913–2002	n	.132	n	.042	n	<.001	n	.011	n	<.001
	4	San Pedro Riv nr Redington	1944–1997	p	.927	n	.539	n	<.001	n	.870	n	.018
	6	Santa Cruz Riv nr Lochiel	1950–2002	p	.004	p	<.001	n	.175	p	.575	p	.581
	7	Santa Cruz Riv nr Nogales	1931–2002	n	.792	n	.601	n	.005	p	.959	p	.980
	8	Sonoita Cr nr Patagonia	1931–1972	p	.322	p	.152	n	.470	n	.699	p	1.000
	9	Santa Cruz Riv at Tucson	<sup>5</sup> 1913–2002	p	.742	p	.014	n	.035	p	.538	n	.202
	14	Whitewater Draw nr Douglas	1931–1982	n	<.001	n	<.001	n	.081	n	.036	n	.010
northwest	1	San Carlos Riv nr Peridot	1930–2002	p	.571	p	.012	n	.070	p	.112	p	.571
	5	Aravaipa Cr nr Mammoth	<sup>5</sup> 1932–2002	p	.405	p	.029	n	.222	n	.883	p	.501
	10	Sabino Cr nr Tucson	<sup>5</sup> 1933–2002	p	.695	p	.240	p	.220	p	.194	p	.046
	11	Pantano Wash nr Vail	<sup>5</sup> 1960–2002	n	.314	p	.953	n	.228	n	.073	n	.260
	12	Rincon Cr nr Tucson	<sup>5</sup> 1953–2002	p	.662	p	.361	n	.307	p	.354	p	.892
	13	Rillito Cr nr Tucson	1914–1975	n	.501	n	.107	n	.013	n	.544	n	.058
northeast	15	Mimbres Riv nr Mimbres	1931–1976	n	.373	n	.272	n	.872	p	.883	n	.857
	16	Gila Riv nr Gila	1929–2002	p	.236	n	.889	p	.487	p	.197	p	.152
	17	Mogollon Cr nr Cliff	1968–2002	n	.842	n	.349	p	.132	p	.573	n	1.000
	18	Gila Riv nr Redrock	1931–2002	p	.479	p	.879	p	.479	p	.520	p	.308
	19	San Francisco Riv nr Reserve	1960–2002	n	.900	p	.675	n	.630	n	.713	n	.786
	20	Tularosa Riv abv Aragon	1967–1996	p	.205	p	.284	p	.112	p	.034	n	.090
	21	San Francisco Riv nr Glenwood	1928–2002	p	.127	p	.437	n	.044	p	.705	p	.179

<sup>1</sup>See figure 2.<sup>2</sup>Trend test was made on seasonal and annual average streamflow.<sup>3</sup>Winter is November–March, spring is April–June, summer is July–August, and fall is September–October.<sup>4</sup>Slope of trend: n is negative and p is positive.<sup>5</sup>Gaging station has more than 10 years of missing data in a continuous block of time within period of record.

		p-value
n or p	no significant trend	> 0.10
n	nearly significant negative trend	0.05–0.10
n	significant negative trend	< 0.05
p	nearly significant positive trend	0.05–0.10
p	significant positive trend	< 0.05

Geographic patterns in streamflow trends were similar to the geographic patterns in precipitation trends—streamflow trends of the San Pedro River Basin were generally similar to streamflow trends of other streams in the southwest part of the study area, and trends in the southwest part were different from trends in the rest of the study area (fig. 7 and tables 4 and 5). The two rivers in the southwest part that had complete records—San Pedro River and Santa Cruz River—had consistently different trends from rivers in the rest of the study area. The San Pedro and Santa Cruz Rivers had consistent negative summer trends, and other streams had no summer trends. For annual flows, the San Pedro River had a negative trend, the Santa Cruz River had no trend, and the rest of the study area had no trends or positive trends.

The patterns of the trends in streamflow at the six gaging stations with complete records were also found in the trends for the gaging stations that did not have complete and consistent records (table 5). Whitewater Draw is the next major watershed to the east of the San Pedro Basin. It had data only from 1931 to 1982, but it had similar streamflow trends as the San Pedro River. All seasons except summer had significant negative trends, and the p-value for summer trends was nearly significant at 0.081. Streamflow at other stations with incomplete records in the northwest and northeast parts of the study area had few significant trends, but most significant trends at the six stations with complete records were for time periods starting in 1930–50 and ending in 2002, and the records at these other stations did not cover that time period.

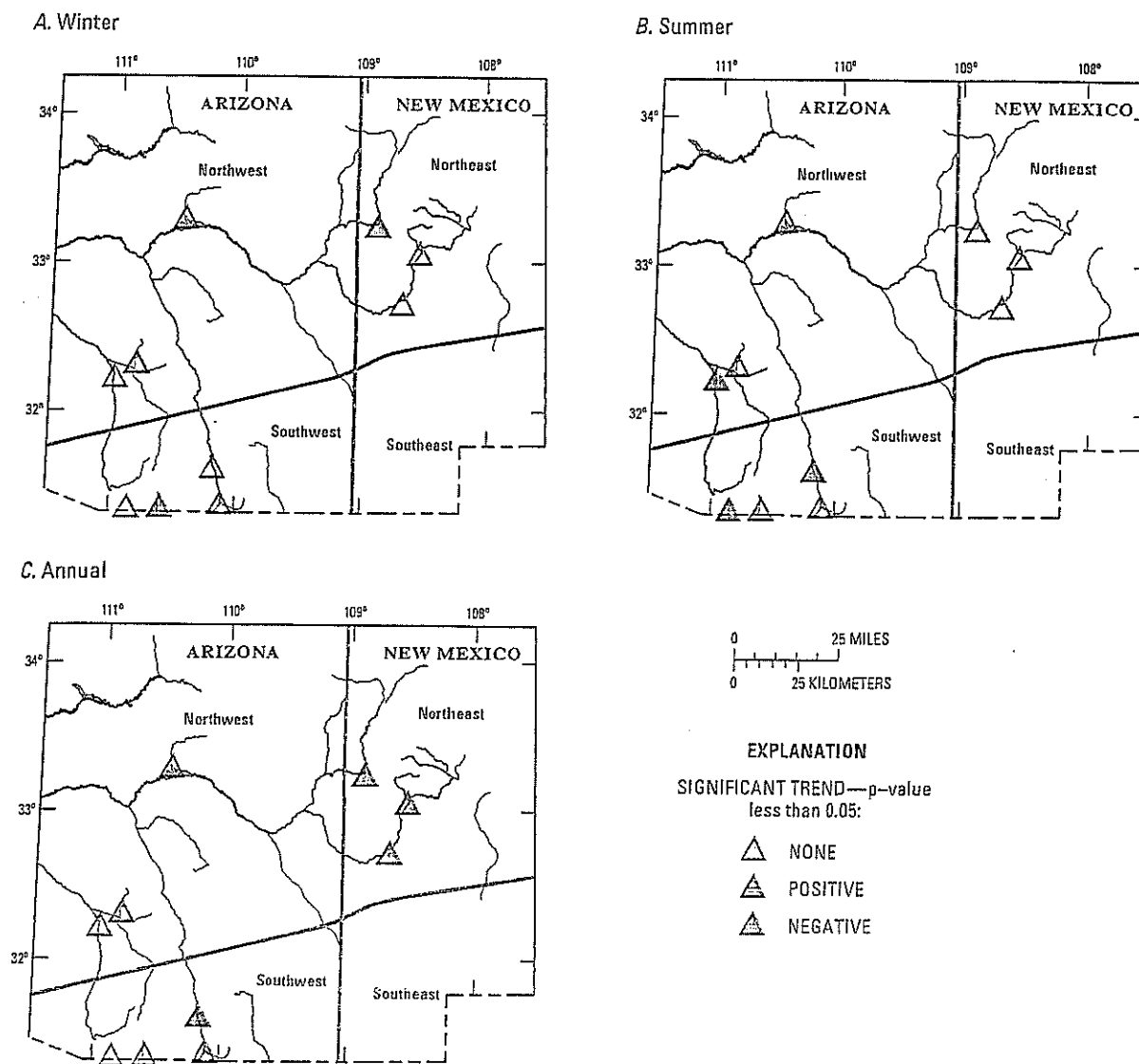


Figure 7. Regional trends in streamflow, 1950–2002. A, Winter; B, Summer; C, Annual.

The decreasing trends in summer flows for Whitewater Draw, the San Pedro River, and the Santa Cruz River could have similar causes. The three watersheds had similar historical changes: upland vegetation changed from primarily grasslands to mostly mesquite woodlands, riparian vegetation increased substantially, and ground-water pumping increased substantially (Turner and others, 2003; Robert H. Webb, U.S. Geological Survey, oral commun., 2004).

## Temporal Patterns or Cycles in Precipitation and Streamflow

There are long-term temporal patterns or cycles in precipitation and streamflow in the study area. Understanding these cycles is important because (1) the cycles influence long-term changes in water supply, vegetation, and other watershed characteristics, (2) the cycles tend to repeat and their magnitude and duration can be used for land- and water-management decisions, and (3) trend analyses are strongly affected by the cycles.

Long-term patterns or cycles in precipitation from 1930 to 2002 are shown in graphs of regional normalized precipitation for the study area (fig. 8). Regional normalized values are an average of the long-term data in the region. Winter and spring precipitation had much more pronounced cycles than did summer or fall precipitation. Winter and spring precipitation were generally high in the 1930s, low in the 1950s and 1960s, high in the 1980s, and low in the late 1990s and early 2000s. The seasons had different interannual variability; spring and fall precipitation had the most variability, winter had moderate variability, and summer had small variability.

The normalized precipitation trends for the southwest part of the study area generally followed the same patterns as the normalized trends for the rest of the study area. The only

notable difference was in summer precipitation from 1930 to 2002; summer precipitation appeared to decrease slightly in the southwest part and increase slightly in the rest of the study area.

Long-term cycles in streamflow from 1930 to 2002 are shown using normalized values for the San Pedro River at Charleston and regional normalized values for the northwest and northeast parts of the study area (fig. 9). Regional normalized streamflow for winter, spring, and fall in the northwest and northeast parts of the study area had long-term patterns similar to those in the precipitation data. A big difference between precipitation and streamflow in those areas was in the summer: summer precipitation had no apparent cycles and small interannual variability, and summer streamflow had large cycles and large interannual variability.

In contrast to the pronounced streamflow cycles in the northwest and northeast parts of the study area, streamflow in the San Pedro River mostly just decreased steadily. Precipitation in all parts of the study area had long-term cycles, and the influence of those precipitation cycles appears in streamflow in the northeast and northwest parts of the study area but not in streamflow of the San Pedro River. This lack of response to precipitation cycles is one indication that other factors besides precipitation could be affecting streamflow of the San Pedro River.

Effects of the recent drought (about the past 5 years) appear as decreasing trends in many of the plots of normalized precipitation and streamflow for all parts of the study area (figs. 8 and 9). There are downturns from 1990 to 2002 in precipitation and streamflow for both winter and spring. Effects of the drought do not appear in summer precipitation in any part of the study area, and other seasonal precipitation and streamflow show mixed effects.